



HANDBOOK
OF
SOUTH AUSTRALIA.

BRITISH ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE.

AUSTRALIAN MEETING, 1914.
ADELAIDE.

DR. C. V. WELLS



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HANDBOOK OF SOUTH AUSTRALIA.

View of Adelaide from Montefiore Hill.



HANDBOOK OF SOUTH AUSTRALIA.



Published by authority of the Government in connection with
the visit of

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT
OF SCIENCE,

AUSTRALLIAN MEETING, 1914.

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Author of "The Central State," "Nile of Australia," etc.

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Director Intelligence and Tourist Bureau.

ADELAIDE :
R. E. E. ROGERS, GOVERNMENT PRINTER, NORTH TERRACE.

1914.



King William Street, Adelaide, looking North from G.P.O. Tower.

PREFACE.

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THE British Association for the Advancement of Science having, at the invitation of the Commonwealth, resolved to hold its annual meeting of 1914 in Australia, the Government of South Australia has authorised and published this Official Handbook of the State.

While the main purpose of the book is to supply to visiting members of the Association information concerning the progress and resources of South Australia, a limited number of scientific articles which bear more or less directly upon the industrial and economic development of the State, or which convey local information not readily obtainable elsewhere, have also been included.

The official details have been supplied by Government Departments or by the Executive Officers of Public Institutions, and the illustrations, except those otherwise acknowledged, have been provided by the Government Photo-lithographic Department.

Subjects of a widely national character, or which pertain to Australia as a whole, are dealt with in the Handbook issued by the Federal Government in connection with the meeting of the Association, and the scope of this book has consequently been limited, as far as possible, to questions which are of special interest or concern to the State of South Australia.

Adelaide, April, 1914.

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BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

AUSTRALIAN MEETING, 1914 ADELAIDE.

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	Lady Symon
	Mrs. P. Waite

INTRODUCTION.

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A MERELY casual glance at the map of Australia reveals the unique geographical position which is enjoyed by South Australia, the southern central State. It covers an area of 243,244,800 acres, and, in proportion to population, has a larger acreage under cultivation than any other State in the Commonwealth. It is already connected by rail with Victoria, New South Wales, and Queensland. The construction of the line which will link it to Western Australia is proceeding, and the building of the railway to connect with the Northern Territory is projected in the near future.

South Australia was declared a province under the British Crown by Governor Hindmarsh on December 28th, 1836, in the reign of King William IV.; was granted self-government in 1857; and on January 1st, 1901, entered into a Federation with the other Australian States.

Although it has only 76 years of history behind it, the progress made by South Australia in many directions has been remarkable. In the intervening years since the proclamation a great deal of developmental work has been undertaken, and many improvements have been effected. The good work initiated by the early settlers has been carried on with vigor by their descendants; and by the exercise of grit, energy, and determination they have subdued the wilderness, developed rural industries, unearthed mineral wealth, reared factories and cities, and weaved the word "success" in capital letters into every national undertaking and industry.

Having regard to the immense area covered, there is no better climate in the world than that which prevails in South Australia. In the southern and agricultural districts the mildness of the temperate zone produces a climate which closely corresponds to that of Italy and Spain. Though the thermometer occasionally in the summer season shows high readings, the weather is not so enervating as in a climate where humid conditions prevail; and heat waves, such as occasionally work disasters in other countries, are unknown. The diversity of the climate, coupled with the varying nature of the soils, has made it possible to produce almost every conceivable variety of cereal, fruit, and vegetable.

Owing to a succession of prolific seasons, South Australia at the present time is enjoying a period of considerable prosperity. Viewed from any standpoint, the State is seen to be resting on very sure foundations, and the future may be contemplated with hope and serenity. Immense areas are

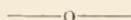
being surveyed and thrown open for occupation. Railways and waterworks are being extended, and every reasonable assistance is given by the Government to the primary producer. The State offers a splendid field for men possessed of agricultural experience and capital to settle and prosper amid almost ideal natural conditions.

Although essentially an agricultural and primary producing country, there are many industries and avenues of activity awaiting development which afford a safe investment for capital.



Glenelg on Commemoration Day.

CONSTITUTION AND PARLIAMENT.



FOR a few years after the proclamation of the province colonists had no voice in the government. The Act constituting South Australia a British province, passed in 1834 in the reign of King William IV., provided that a constitution should be granted to the inhabitants "as soon as they numbered 50,000 souls." Under this Act a Board of Colonisation Commissioners was appointed in London. This board controlled land sales and emigration, and for a brief period exercised considerable authority in other directions. Until 1851 executive control was vested in the Governor and a



Parliament Houses.

council, appointed by His Excellency and dominated by him. After 15 years' experience of indirect management by a board 16,000 miles away, in a period when communication was intermittent, and direct government on the spot was vested in one man responsible only to the Imperial authorities, who knew little of colonial affairs, a measure of self-government was granted. The population at that time consisted of 66,538 persons—37,321 males and 29,217 females.

The Imperial Act authorised the formation of a Legislative Council not exceeding 24 members, one-third of whom were to be nominated by the Governor and two-thirds elected by householders and property owners. The qualification for membership in the first legislature was a freehold property of the annual value of £100, or of the total value of £2,000. This council had distinct limitations, having no power to deal with the land, which remained in the hands of the representative of the Imperial Government. During the next few years political growth was rapid, and in 1853 a Bill constituting a bicameral legislature was passed, but was disallowed. By 1856, however, the pioneers were in possession of a Constitution the essential principles of which remain. In that year the bicameral system of government was introduced, for the Act of 1856 created two Houses—a Legislative Council, consisting of 18 members elected on a property qualification franchise—now household, with the single vote—the whole province voting as one electorate; and a House of Assembly, composed of 36 members, elected on the manhood suffrage basis. Subsequently the members of the Assembly were increased to 54, and again reduced (1902) to 42; but on the transfer of the Northern Territory to the Commonwealth in 1910 the two members for that constituency retired. Again in 1913 the number was raised to 46. The Council membership, after being increased to 24, was reduced (1902) to its original number, and by the Act of 1913 was increased to 20, elected by five districts. Manhood suffrage obtained from the outset in respect to elections for the House of Assembly, and the only variation was the granting of the vote to women in 1894, which made the franchise for that Chamber adult suffrage. Women vote for both branches of the legislature under the same condition as men. In 1887, the system of payment of members was introduced, under which legislators are paid £200 a year. There are six Ministers (one Honorary), who receive a total allowance of £5,000 a year. The State Parliament is triennial, with annual sessions.

The power of both Houses was originally co-ordinate, excepting that Bills for appropriating any part of the revenue, or for imposing, altering, or repealing taxation must originate in the Assembly. An attempt, however, on the part of the Upper Chamber in 1857 to amend a Money Bill was strenuously and successfully resisted by the Assembly. A great political battle, which shook the little province to its very foundations, took place in the year named over the "Tonnage Duties Repeal Bill," and in order to avoid the repetition of such a struggle it was eventually agreed that the Council should not insist on claiming the right to "amend" Money Bills, but should formulate "suggestions." This device has of late years been adopted with good results in Western Australia and Victoria, and by the Commonwealth. In 1913 this practice received the sanction of law.

South Australia has also led the way in several important reforms, having been the first State of the Australian group to enjoy elective Houses, manhood, and subsequently adult, suffrage, for one chamber, voting by ballot, payment of Members, and women's suffrage. It was also the first of the States to adopt the principle of taxation of land values, granting the municipal vote to women, legalising marriage with deceased wife's sister, separating Church from State by abolishing State grants to religion, and passing the Real Property Act. The objects of the Real Property Act are to give security and simplicity to all dealings with land, by providing that the title shall depend upon registration; that all interests shall be capable of appearing or being protected upon the face of the registry, and that a registered title or interest shall never be affected by any claim or charge which is not registered. By this system everyone who acquires any estate or interest in land, upon being registered as owner thereof, obtains a title absolutely secure as against everyone whose claim does not appear upon the registry; and the two elements of simplicity and security as regards the acquisition of land appear to be effectually attained. The Real Property Act of South Australia has been copied by all the Australian States and in other parts of the world.

The South Australian ballot system has been adopted by all the Australian States, and is largely in use in the United States of America. The method of voting is as follows:—Each elector is given a voting paper containing the names of the candidates, with a square set opposite each name. The voter enters a private apartment and puts a cross within the square opposite the name of the favored candidate. The folded paper is handed to the returning officer and he, in the presence of the voter, drops it into a sealed box. Secrecy is thus assured, and no matter how high political feeling may run at election time, there is the utmost decorum within the polling-booth.

South Australia also initiated a very fine system of local self-government by means of Municipal Corporations and District Councils. These bodies, in addition to having control over streets and certain roads, are vested with considerable local authority. In addition to fostering the important principles of self-government, the plan has encouraged self-help among people in remote districts, and has had the effect of lightening the labors of the State legislature regarding matters of local concern, whilst relieving the central government of much detail administration.

South Australia entered the Commonwealth of Australia on January 1st, 1901, as one of the six original States. South Australia was always strongly federal in sentiment, and exercised considerable influence at every stage of federal evolution. At the various conferences and conventions the South Australian representatives stood out prominently for a united Australia. When the Commonwealth Constitution was submitted to the electors of South

Australia for approval, 65,990 electors voted for union and 17,053 against. South Australia enjoys the right to elect seven members to the House of Representatives. There is equal representation of all States in the Senate, but membership in the other chamber is regulated by population.



Torrens Lake, Adelaide, showing Parliament Houses.

GOVERNOR, EXECUTIVE COUNCIL, MINISTRY, AND PARLIAMENT.

GOVERNOR.

Galway, K.C.M.G., Sir Henry.

LIEUTENANT-GOVERNOR.

Way, Bart., Chief Justice, P.C., D.C.L., LL.D., The Right Hon. Sir Samuel James; commission dated January 9th, 1891.

Until 1858 a commission from the Crown to administer the Government in the event of there being no Governor, or in his absence, was held by the senior member of the Executive Council; thereafter until 1870 the dormant commission was held by the officer commanding H.M. Forces; and subsequently by the Chief Justice.

MINISTRY.

(Assumed Office, February 17th, 1912).

Bice, The Hon. John George, M.L.C., Chief Secretary.

Butler, The Hon. Sir Richard, K.B., M.P., Commissioner of Public Works, Minister of Mines, and Minister of Marine.

Homburg, The Hon. Hermann, M.P., Attorney-General and Minister of Industry.

Pascoe, The Hon. Thomas, M.L.C., Minister of Agriculture and Irrigation.

Peake, The Hon. Archibald Henry, M.P., Premier, Treasurer, and Minister of Education.

Young, The Hon. Frederick William, LL.B., M.P., Commissioner of Crown Lands and Immigration.

THE PARLIAMENT.

LEGISLATIVE COUNCIL.

List of Members, with their Metropolitan Addresses.

The Honorable—

Addison, Arthur Richman (*Northern*), Legislative Council.

Bice, John George (*Northern*), Legislative Council.

Cowan, John (*Southern*), Legislative Council.

Downer, Sir John William, K.C.M.G. (*Southern*), King William Street.

Gordon, David John (*Midland*), Grenfell Street.

Hannaford, Walter (*Midland*), Legislative Council.

Howe, James Henderson (*Northern*), Legislative Council.

Jolley, James (*Central*), Legislative Council.

Klauer, Ernest Leopold William (*Central*), Legislative Council.

Lewis, John (*Northern*), King William Street.

Lucas, Edward (*Midland*), Legislative Council.

Pascoe, Thomas (*Midland*), Legislative Council.

Stirling, Sir John Lancelot, K.C.M.G. (*Southern*), Adelaide Club.

Styles, Alfred William (*Central*), Legislative Council.

Vaughan, John Howard (*Central*), Legislative Council.

Von Doussa, Alfred (*Southern*), Legislative Council.

Wallis, Frederick Samuel (*Central*), Legislative Council.

Wilson, James Phillips (*Central*), Legislative Council.

President and Chairman of Committees—Hon. Sir John Lancelot Stirling, K.C.M.G., LL.B.

Clerk of the Council and Clerk of the Parliament—Frederick Halcomb, M.A.

Clerk-Assistant and Sergeant-at Arms—James Percy Morice.

HOUSE OF ASSEMBLY.

(21st Parliament, commencing March 19th, 1912).

List of Members with their Metropolitan Addresses.

Angus, William (*Victoria and Albert*), Parliament House.
Anstey, Edward Alfred (*Adelaide*), Parliament House.
Blundell, Reginald Pole (*Adelaide*), Parliament House.
Bodey, George (*Victoria and Albert*), Parliament House.
Burgoyne, Thomas (*Flinders*), Parliament House.
Butler, The Hon. Sir Richard, K.B. (*Barossa*), Parliament House.
Chesson, Henry (*Port Adelaide*), Parliament House.
Cole, William James Cooper (*Stanley*), Parliament House.
Coneybeer, Frederick William (*Torrens*), Parliament House.
Denny, William Joseph (*Adelaide*), Parliament House.
Duhst, Oscar Hermann (*Wooroora*), Parliament House.
Goode, Clarence (*Stanley*), Parliament House.
Green, Thompson (*Port Adelaide*), Parliament House.
Hague, William (*Barossa*), Parliament House.
Heggaton, Percival Thomas (*Alexandra*), Parliament House.
Herbert, John Frederick (*Wallaroo*), Parliament House.
Homburg, The Hon. Hermann (*Murray*), Parliament House
Homburg, jun., Robert (*Burra Burra*), Parliament House.
Hudd, Herbert Sydney (*Torrens*), Parliament House.
Jackson, Harry (*Stanley*), Parliament House.
James, David (*Wooroora*), Parliament House.
Laffer, George R. (*Alexandra*), Parliament House.
McDonald, Alexander (*Alexandra*), Parliament House.
MacGillivray, Ivor (*Port Adelaide*), Parliament House.
Miller, William (*Burra Burra*), Parliament House.
Moseley, James Grey (*Flinders*), Parliament House.
O'Loughlin, The Hon. Laurence (*Burra Burra*), Parliament House
Parsons, Herbert Angas (*Torrens*), Parliament House.
Peake, The Hon. Archibald Henry (*Victoria and Albert*), Parliament House.
Pflaum, Friedrich Jacob T. (*Murray*), Parliament House.
Ponder, William David (*Adelaide*), Parliament House.
Ritchie, George (*Alexandra*), Parliament House.
Rudall, Samuel Bruce (*Barossa*), Parliament House.
Smeaton, Thomas Hyland (*Torrens*), Parliament House.
Southwood, John Albert (*Wallaroo*), Parliament House.
Travers, John (*Flinders*), Parliament House.

HOUSE OF ASSEMBLY—*continued.*

Vaughan, Crawford (*Torrens*), Parliament House.
Verran, The Hon. John (*Wallaroo*), Parliament House.
Young, Henry D. (*Murray*), Parliament House.
Young, The Hon. Frederick William (*Wooroora*), Parliament House.
Speaker.—The Hon. Laurence O'Loughlin.
Chairman of Committees.—Samuel Bruce Rudall.
Clerk of Assembly.—John Cummins Morphett.
Clerk-Assistant and Sergeant-at-Arms.—Alfred Searcy.



Glen Osmond Pass,

LOCAL GOVERNMENT.

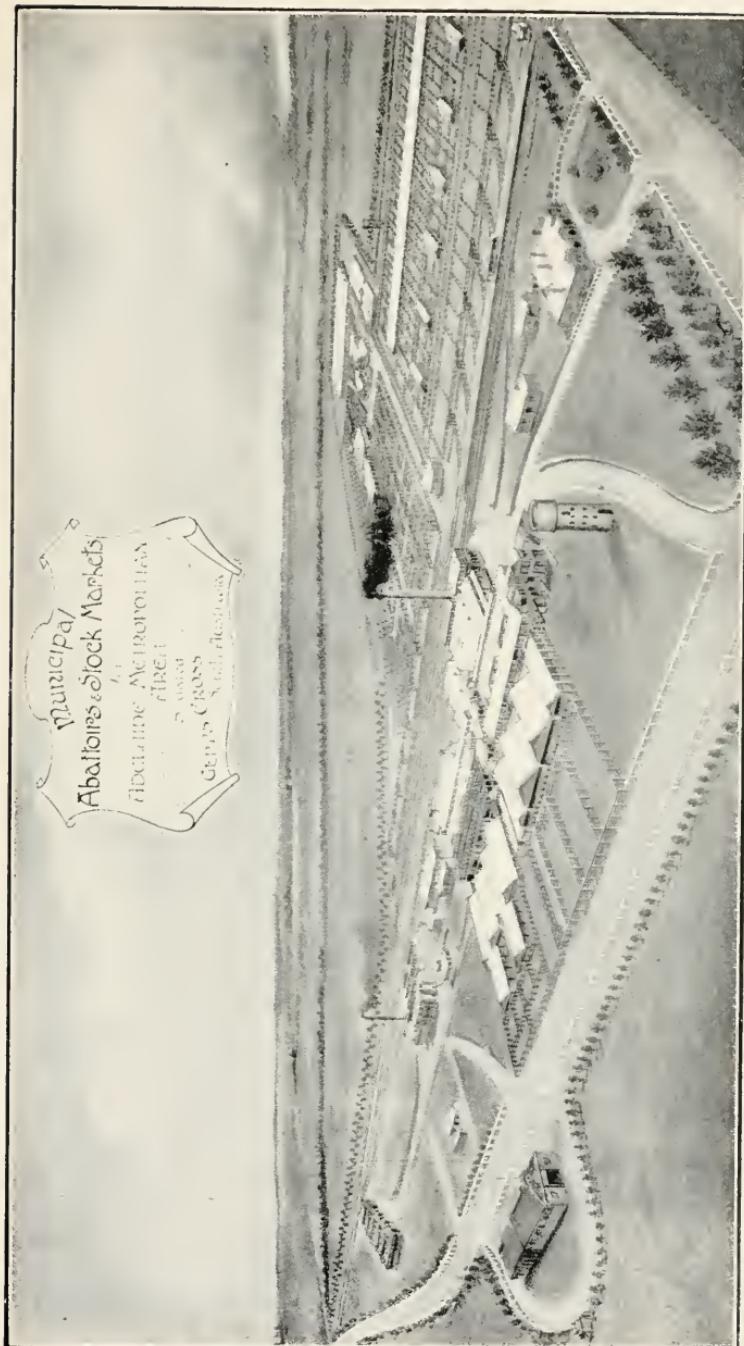
SOUTH AUSTRALIA originated the fine principle of local government which prevails in Australia by passing in 1839—three years after the proclamation of the province—the first Australian municipal law. On October 31st, 1840, the principles of self-government were adopted by the election of a mayor and councillors for the city of Adelaide. Sydney followed two years later. Municipal corporations and district councils have been generally extended throughout the State.

Municipalities were first established under the Municipal Corporations Act of 1861, which, after providing for the extension of the powers and duties of the corporation of the city of Adelaide, authorised the Governor, on petition of a majority of not less than two-thirds of the property owners, to incorporate any town, district, or place within the province a municipality. This Act and its amendments were consolidated in the Municipal Corporations Act of 1880, which was amended from time to time until the year 1890, when it was repealed and its provisions consolidated by the existing Act, the Municipal Corporations Act of 1890, which was in turn amended in 1903 and 1909. These Acts were again altered by the Local Government Act, 1910.

After making provision for continuing existing corporations and by-laws, the Act of 1910 authorises the Governor to constitute new municipalities, or to alter the boundaries of existing ones, on petition of not less than two-fifths of the ratepayers or owners of ratable property within the land proposed to be incorporated, separated, or added; and also to rearrange, increase, or diminish the number of wards of a municipality on petition of not less than one-fifth of the ratepayers.

Each council consists of a mayor, and of two councillors for each ward, while provision is also made for the election of not more than six nor less than three aldermen (representing the whole of the ratepayers) where a poll of citizens has declared in favor of the creation of aldermen. The qualification for councillor is that a candidate must be a ratepayer in the municipality in which he seeks election, while candidates for the positions of mayor or aldermen, besides possessing the foregoing qualification, must have served at least one year in some municipal council.

All persons of full age, if British subjects and not in receipt of public relief or alms, who are either owners or occupiers of any ratable property within a municipality are entitled to vote at the election of the mayor, aldermen, and



councillors. Provision is made for the nomination and election of the mayor, aldermen, councillors, and auditors, and for regulating the meetings of the councils.

The first District Councils Act was passed in 1858, was amended in 1862, and was further amended and consolidated by the District Councils Act of 1876, which provided for the continuation of existing districts and for the establishment of new ones by proclamation on the petition of the ratepayers. The revenue of the councils consisted of rents, profits, and income from lands vested in the council or over which the council had the control and management; fines and penalties enforced under the Act; fees for licences; and general and special rates and loans. Provision was made for the election of councillors, their number, qualification, and retirement; for the election of auditors; the meetings, powers, and functions of councils; the appointment of constables; revenue and expenditure; assessment and rates; and for making by-laws for various purposes. The Act of 1876 was amended from time to time, and was finally amended and consolidated by the Act which is now in force, namely, the District Councils Act of 1887, which has in turn been amended in the years 1899, 1890, 1897, 1904, and 1905. These Acts were again amended by the Local Government Act, 1910.

The District Councils Act, 1887, provides for the continuation and amalgamation of existing districts, and for the constitution as a new district of any part of the State containing ratable property capable of yielding upon a rate not exceeding 1s. in the pound the sum of £200. The Governor is authorised to alter the area or boundaries of any district by annexation or by subdivision. New districts are constituted upon petition to the Governor. Every petition must be signed by 50 inhabitants of the part sought to be constituted, and if the proposed district comprises portion of a previously existing district, by a majority of the ratepayers of such portion.

METROPOLITAN ABATTOIRS AND STOCK MARKETS.

Under the Metropolitan Abattoirs Act, 1908, a board consisting of eight members was constituted for the purpose of erecting and managing abattoirs and stock markets for the metropolitan area.

The City of Adelaide has two representatives on the Board, and one of them (the Right Worshipful the Mayor) is *ex-officio* chairman. The other six members represent 16 suburban municipalities and district councils.

The Board under its original Act was empowered to borrow up to £100,000, but during the 1910 Session of Parliament, owing to the enlargement of the area under the Board's jurisdiction and of the scheme for Abattoirs and stock markets, an amending Bill was passed, increasing the Board's capital to £250,000.

Later, the master butchers in the area of jurisdiction approached the Board and asked that it undertake the slaughtering of stock and delivery of meat from the Abattoirs to the butchers' premises. After lengthy consideration the Board decided to do so, and in 1911 Parliament passed a further measure increasing the capital of the Board to £305,000 to enable it to purchase motor lorries for carrying the meat and to erect cottages for the workmen, &c. Subsequently, during the 1912 Session, another Act was passed, which advanced the Board's capital to £353,000.

The Abattoirs and markets are established at Gepp's Cross, about six miles from the city, where 611 acres of land were purchased, on a portion of which stock is grazed while awaiting slaughter.

An extensive sewerage system has been laid, an electric generating plant installed, premises for boiling down diseased carcasses constructed, and boilers and refrigerating plant erected.

The construction work in connection with the buildings was commenced in October, 1910, and the markets work in September of that year.

Extensive railway sidings have been put into the Abattoirs and markets at a cost of £30,000.

The work of paving the sheep market cost about £18,000.

The works were publicly opened with fitting ceremony on the 12th July, 1913, by the then Mayor of Adelaide (Mr. J. Lavington Bonython) in his capacity as Chairman of the Managing Board.

Under its Acts the Board has an absolute monopoly of the slaughtering of cattle within the area, thus ensuring a pure meat supply to a population of over 200,000 persons.

The estimated annual revenue is £100,000, and the number of officials and employés in all branches is approximately 350.

Mr. T. George Ellery, the Town Clerk of Adelaide, is the General Manager.

FOOD AND DRUGS.

The Metropolitan County Board, which was created by the Food and Drugs Act, 1908, is composed of 22 representatives from 19 municipal and district councils in the metropolitan area.

The Board is charged with the oversight of the people's food supply, and is the outcome of a voluntary association of the metropolitan councils, which for some years dealt with the milk supply of the city and suburbs.

This association, being a voluntary body and consequently having no legal status, took steps to remedy the defect, and this was effected by the Act mentioned above. The Board came into existence on October 7th, 1909.

Since its formation the Board's officers have been actively engaged in carrying out the provisions of the Food and Drugs Act, to ensure to the inhabitants of the metropolitan area unadulterated and wholesome food.

PUBLIC REVENUE AND EXPENDITURE.

THE Treasury is the controlling department in connection with all financial transactions of the South Australian Government, and receives revenue from all sources of the public income, either from the public direct or through the various revenue collecting departments, and classifies the receipts under their proper heads.

All public expenditure is paid in cash at the Treasury under a system by which the various departments issue cheques or orders on the Treasurer in payment for services or supplies to the State. Surplus funds are invested with banks and other reliable financial institutions. The Treasury conducts the floating of loans and performs daily all work in connection with the Public Debt in the State, and redeems Government securities as they fall due.

Out of a Public Debt of £30,000,000, £13,000,000 is due to Australian investors, thus showing the confidence of the local capitalists in the resources of the State. Five-sixths of the debt has been expended on railways, waterworks, and other revenue-producing undertakings, and they form a valuable asset of the State.

During the year ended June 30th, 1913, £7,333,380 was received in cash in the Treasury, compared with £3,805,245 ten years ago.

How REVENUE HAS EXPANDED.

From the modest beginning of £5,283 in 1837 the "general expenditure" of South Australia has grown to £4,330,282, and from a few hundred pounds in 1838 public revenue has expanded to £4,506,698. For years deficits had to be faced, and more than once financial disaster was imminent ; but the sound common sense which marked the development of the natural resources of the colony manifested themselves in the financial arena also, and recent years have provided a succession of comfortable surpluses. South Australia enjoys, in common with the other States of the Commonwealth, financial autonomy. The power of the purse is in the hands of a representative Chamber elected on adult suffrage.

The growth of the State's finances is adequately portrayed in the following statement of revenue, expenditure, and population.

			Revenue.	Expenditure.	Population.
			£	£	
1893-1897	..	..	2,513,951	2,573,035	251,172
1898-1902	..	..	2,636,440	2,678,506	356,061
1903-1907	..	..	2,978,528	2,804,765	371,738
1908-1912	..	..	3,964,774	3,616,722	406,029
1913	..	..	4,330,282	4,506,698	433,718

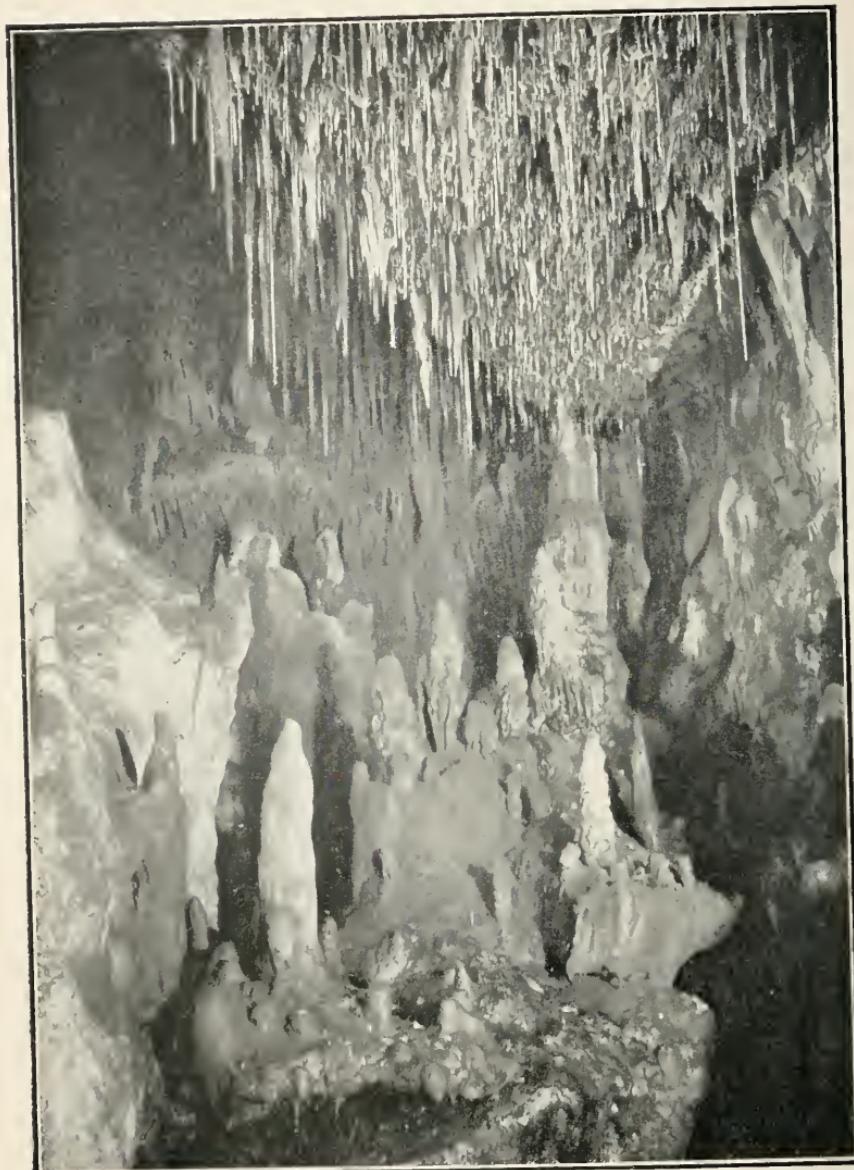
The buoyancy of the accounts in recent years is indicated by the fact that since July 1st, 1904, there has been transferred surplus revenue for the redemption of the public debt amounting to £2,377,528. For the last decade expenditure compares with revenue as follows:—

Year ended June 30th.	Revenue.	Expenditure.	Excess of Revenue over Expenditure.	Excess of Expenditure over Revenue.
1904 ...	£ 2,510,955	£ 2,543,185	£ —	£ 32,230
1905 ...	2,725,724	2,650,020	75,704	—
1906 ...	2,806,011	2,718,537	87,474	—
1907 ...	3,195,285	2,897,612	297,673	—
1908 ...	3,654,666	3,171,143	483,523	—
1909 ...	3,551,189	3,259,417	291,772	—
1910 ...	3,985,806	3,513,051	472,755	—
1911 ...	4,181,472	3,964,411	217,061	—
1912 ...	4,450,739	4,175,589	275,150	—
1913 ...	4,506,698	4,330,282	176,416	—

SOURCES OF REVENUE.

As already pointed out, the sources of the State's revenue are chiefly direct taxation and public services. Under the former is embraced income tax, land tax, stamp duties, probate and succession duties and licences, while the public works and services include education, marine, railways, waterworks, and such-like, the most important being railway receipts, which account for about half the revenue of the State. Below is contrasted the income from all sources in the financial year to June 30th, 1913, with the figures for 1912—

	1912.	1913.
	£	£
Taxation	551,994	..
Public Works and Services.....	2,600,930	..
Other Receipts	307,316	..
Territorial	478,780	..
Commonwealth	511,719	..
 Total Revenue.....	 4,450,739	 ..
 Net Increase	 (1912) 269,267	 (1913) 55,959



View in Naracoorte Caves.

FRIENDLY SOCIETIES.

AN analysis of the South Australian Savings Bank figures clearly demonstrates that the people of Australia are not a whit less provident in their habits than the populations of other countries. Further evidence of this is provided by data respecting Friendly Societies. As a matter of fact in a comparison between the populations and investments in Savings Banks and Friendly Societies in the six States of the Commonwealth, as well as in Great Britain and Ireland, the Public Actuary shows that South Australians head the list as the most thrifty people in the Empire. In 1909, this State, with its then population of 396,400, boasted 201,275 depositors in the Savings Bank, with an average amount to credit of £33 14s. 10d., or an average per head for the total population of £17 2s. 8d. At the same time the capital per member in Friendly Societies in this State amounted to £14 16s. 5d. Western Australia was second on the list in Savings Bank deposits, with an average per head of the population of £13 2s. 1d., and Victoria was second so far as Friendly Societies' capital was concerned, with £14 15s. 3d. The average Savings Bank deposit for the whole of the Commonwealth was £12 5s. 8d., and Friendly Societies' capital, £12 10s. 1d. So it will be seen that South Australia goes far to establish Australia's reputation for thrift. Great Britain's average Savings Bank deposit amounted to only £5 13s. 8d., and Friendly Societies' capital to £5 19s. "The people of this State," says the Public Actuary, "are to be congratulated upon the favorable position occupied by South Australia in this respect. Regarded from the population basis, the figures show that habits of thrift among the people here are more deeply rooted than elsewhere."

The following statement shows the number of registered Friendly Societies in Australia at the dates of the latest reports; also the numerical and financial strength of each. The membership in South Australia, Victoria, New South Wales, and Western Australia includes females, and in Queensland it includes females and juveniles:—

	Number Societies.	Number M ^{em} b ^{rs} .	Total Funds. £	Capital per Member. £ s. d.
South Australia . . .	16 ..	58,292 ..	863,998 ..	14 16 5
Victoria	48 ..	142,275 ..	2,122,602 ..	14 18 5
New South Wales ..	42 ..	149,442 ..	1,419,695 ..	9 10 0
Queensland	21 ..	42,246 ..	546,430 ..	12 18 8
Tasmania	11 ..	21,063 ..	198,079 ..	9 8 1
Western Australia .	17 ..	16,397 ..	158,567 ..	9 13 5
 Total	 168 ..	 501,486 ..	 6,750,721 ..	 13 9 3

OLD-AGE SICKNESS.

All registered Friendly Societies in South Australia assure the sickness benefit to the end of life, but the necessity of substituting a superannuation allowance for sick pay during the years of life when man is physically incapable of work has been urged upon Friendly Societies by actuaries during many years. The rate of sickness increases with accelerated speed after the age of 60 is reached. The average duration of sickness at age 17 to age 60 is nearly 1 1-12 weeks per member per annum ; 60 to 69 the duration increases to 5 7-10 weeks per member ; 70 to 80 it is 13 3-5 weeks ; whilst at 80 and after it becomes almost continuous. The following abstract showing the aggregate weeks of sickness per member during the various age-periods affords proof of the increased liability imposed on the funds by old age :—

Age period.	Weeks.	Days.	Age period.	Weeks.	Days.
17 to 60 ..	53 ..	5	60 to 80 ..	215 ..	2
17 to 70 ..	114 ..	2	70 to 80 ..	154 ..	5
17 to 80 ..	269 ..	1	80 to end of life	468 ..	0
60 to 70 ..	60 ..	3			

The fluctuations in the rates of sickness at age 70 and after, arising from the excessive quantity of sickness and the paucity of members, render the data so unreliable that the results have to be disregarded in constructing monetary tables for valuation purposes. For example, the experience to which reference has been made shows that for the age-period 17-60 the number of members at risk was 346,782, with a total of 376,429 weeks of sickness ; but during ages 60-80 there were only 35,912 members, and the quantum of sickness was 275,454 weeks ; and for the age-period 70 to the end of life the number of members was 9,707, with 141,042 weeks of sickness, nearly all of which was probably due to natural decay and not to specific sickness. It is because of these fluctuations, and of the unreliability of the average results derived therefrom, that it is considered desirable to exclude old-age sick pay, and substitute therefor a permanent weekly allowance on attaining age 65 or 70. Many societies in England have adopted these alterations, but to do so it has been necessary for them to substitute adequate graduated rates of contribution for the inequitable and unjust uniform rate formerly prevailing. Societies in this State whose members pay adequate rates graduated according to the entry age could, without any difficulty, exchange the value of the sick pay after age 70 for its equivalent in the form of a permanent weekly allowance to the end of life on attaining that age.

BENEFITS AND FINANCIAL IMPROVEMENT.

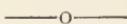
Not one of the many benefits, direct or indirect, dispensed by Friendly Societies can be regarded as a charity. They are all provided out of the contributions of a few pence per week, paid into the lodge by the members.

As showing the magnitude to which these benefits in the aggregate have attained in the past (and they will continue to increase in the future if a proper adjustment of the contributions and benefits is adopted) the following from the disbursements during the past 15 years, 1895-1909, of all registered societies is interesting :—For sick pay, £689,332 ; funeral donations, £324,455 ; medical attendance and medicines, £388,405 ; total, £1,402,192. So far as the male members of all societies are concerned the ratio of assets to each £1 of the liabilities has improved from 11s. 9d. in 1892 to 17s. 3d. in 1909. The general financial improvement disclosed in the valuations is due to two causes—(1) Favorable mortality and sickness experience. (2) Reduction of the benefits and increase of the contributions in many societies. Compared with the 1904 valuations the aggregate of the assets increased during the quinquennium to 1909 from £1,683,326 to £2,102,642, equal to 25 per cent. : while the liabilities during the same period decreased from £2,167,195 to £2,435,756, or $1\frac{1}{4}$ per cent., results which must be regarded as highly satisfactory. The aggregate movements in membership from 1904 to 1909 were :—Males, number at beginning of period, 43,651 ; admissions, 19,447 ; departures, 12,307 ; net increase, 7,140 ; number at end of period, 50,791. Females—Number at beginning of period, 5,602 ; admissions, 4,928 ; departures, 3,029 ; net increase, 1,899 ; number at end of period, 7,501. The average annual increase during the five years was :—Males, $3\frac{1}{4}$ per cent. ; females, 6 4-5 per cent. During the five years ended December 31st, 1909, the aggregate amount of the sick and funeral funds increased from £634,934 to £820,328. The expansion of £186,294 compares with a growth of £126,919 during the preceding quinquennium.



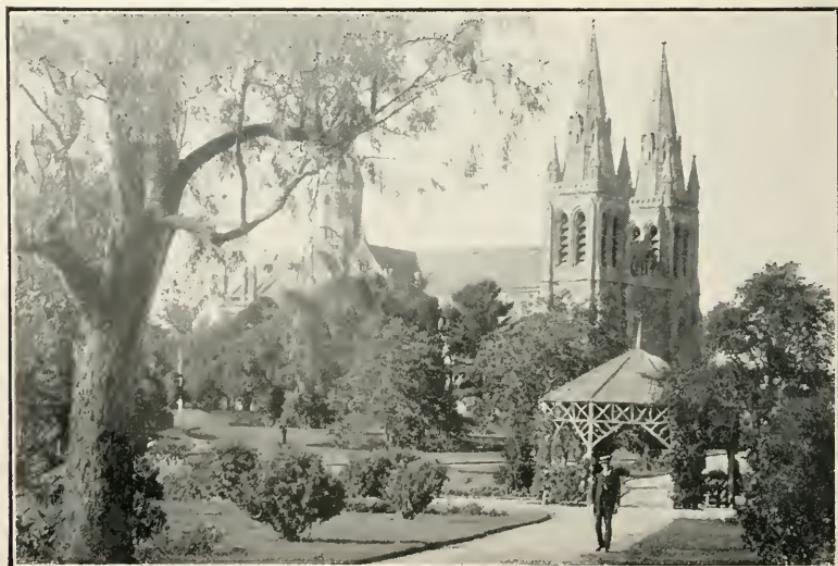
View in Long Gully, National Park.

CHARITABLE INSTITUTIONS.



FOR a community of little more than 400,000 people, South Australia has an astonishing number of philanthropic institutions—in many instances on a large scale—to the support of which private donations wholly or largely assist. Beside the Destitute, State Children's, and Lunacy Departments—wholly under the Government ægis—and the hospitals, which number 21, that are mainly so—there are four aboriginal mission stations towards the upkeep of which private benevolence contributes about one-twelfth the income from all sources. The following (from the official statistics at end of 1912) show the other principal establishments, with the number of inmates, at end of year:—Lying-in home (Queen's Home), 41; four orphan asylums, 191; five neglected children homes, 175; three reformatories, 75; three deaf and dumb institutions, 174; home for weakminded children, 77; creche, say, 16; Kalyra Sanatorium, 27; convalescent hospital, 41; six refuges and night shelters, 206; home for incurables, 119; and four other institutions, 115. The hospitals averaged 653 resident patients daily, and all other charitable institutions (Government and private) had 3,391 inmates at the end of the year.

In the present year the Blind and Deaf and Dumb Institution at Brighton has received private gifts aggregating £5,000 for extension work, entitling it to a subsidy from the Government of an equal amount.



PENNINGTON PARK AND ANGLICAN CATHEDRAL, ADELAIDE.

CARE OF STATE CHILDREN.

By MARGARET WRAGGE, *Member of the State Children's Council.*

SOUTH Australia has been a pioneer in its dealing with destitute and neglected children.

The authority to whom they are entrusted, no less than the method of treatment adopted by that authority has a character of its own.

The authority combines in a unique way the services of salaried and honorary workers—the official and the volunteer. Its head is the Chief Secretary of the South Australian Government, who appoints the State Children's Council to work under him. The Council consists of 12 public citizens—six men and six women—one-third of whom retire annually, but are eligible for reappointment. The whole of the work of the Department—appointment of officers, approval of homes, placing out or recall of children, supervision of institutions, &c.—passes before the Council for decision. The Secretary of the Council is the chief salaried officer of the Department, and he has power to act between meetings, his actions being subsequently ratified. A large clerical staff works under him in the office ; and there are women probation officers, inspectors (both men and women), doctors, nurses, and teachers, whose paid work is given ungrudgingly and in the spirit of the volunteer. The time that is freely given by the members of the Council and by the visitors and local committees who do the work in country districts, their personal interest, and their really intimate knowledge of the work of the Department, are their contribution of disinterested service. So much for the authority.

The treatment of the children varies with the needs of each case. They come under the care of the Council through committal by the Children's Court, held in places or at times apart from the ordinary court cases. They are classed as—(1) convicted ; (2) neglected—(a) uncontrollable, (b) illegitimate, (c) in unfit guardianship ; (3) destitute. Such children may be sent either (a) to an institution or (b) to “the custody and care of the State Children's Council.” The institutions to which the child may be sent are all under the control of the Department, and are graded, viz., Industrial School, Probationary School, and Reformatory. A child may be subsequently transferred from one grade of institution to another, or boarded-out on subsidy or service terms. The second alternative treatment mentioned above (b) is similar to that known as “release on probation.” The child returns to his parents, subject to watchful inspection on the part of the Department, with the risk of recall on a bad report and subsequent recom-

mittal without further trial. The success of this method will be mentioned later. But the majority of the children are "boarded-out" in ordinary homes all over the State, those over 13 being placed in service and receiving wages according to a fixed tariff, those under that age being paid for by the Department at a subsidy scale varying with the child's age.

The boarding-out system has now been adopted by other lands, but it originated here, and is South Australia's contribution towards the solution of the problem of dealing with destitute children. In the Council's report for 1913 it is stated that in that year there were 1,575 State children under the Council's control; and of these 1,321 were boarded out, the remainder (254) being in institutions under the supervision of the Department. The receiving home and also the two reformatorys for Protestant children are under its direct management. The other institutions are the property of different religious bodies, but are subsidized and inspected by the Council, *i.e.*, the Roman Catholic Reformatory for boys, and the two probationary schools for boys and girls belonging to the Salvation Army. The Council is glad to make use of all these institutions for special cases, but it believes that home life in an ordinary family is the best training for a child. Real ties of affection are formed, and the destitute ceases to be destitute when he has found the love and comradeship of a true home. If only wise foster-parents can be found, it is worth paying a higher subsidy for a difficult child rather than to do the easy thing and to commit him to an institution, where nobody has time to study his idiosyncrasies. It is possible that there may be less and less need for institutions in the future.

The development of the probation system is a move in this direction. It was first applied in South Australia in 1906. It has proved a valuable means of reform, first in dealing with convicted children, and later by providing a transition stage between State control and absolute release, where the circumstances which led to the committal of a destitute or neglected child have changed for the better. So far, this work has been in the hands of two excellent officials—both women; but it is increasing so rapidly that further help will be needed, and there seems no reason against the employment here of competent volunteers working under the direction of the trained and salaried officers.

The subsidy and service homes are subject to very searching inspection before children are sent to them, and as long as they remain in them. Dissatisfaction on either side results in recall. The State children are under the Council's care (unless the Council releases them)—the boys till 18 years and the girls till 21 years. They are provided at the outset with good outfits, which have to be kept up to the satisfaction of the inspectors, who periodically visit them in their homes. Free medical and dental treatment is also given by the

Department to all State children. As far as possible the children are placed with foster-parents who belong to the same church as themselves, and everything is done to make the family tie as strong as possible. The boys generally take to farm work and the girls to domestic service, but opportunities for other employment are given to those who show special aptitude or strong inclinations. Part of the wage all through the time of tutelage is held back by the Department and handed to the ward on his release.

The boarding-out system, with the close supervision which accompanies it in South Australia, gives scope for a full, free life to the wards of the State and the latest report (1913) states in a table covering the discharges of the past five years that 70·3 per cent. are known to be doing well. This table counts those "not known" as "bad," and so rather understates the actual number of successes. If half of the "not known" were good, the percentage would be 80·8 "doing well." But in any case, the results are an encouraging proof of the value of the system, which has been at work since 1872.

The care of illegitimate infants is a later development of the work of the State Children's Department. The need for such care was proved by the heavy rate of mortality amongst such children, and now they are by law under the council's supervision till they reach the age of 7 years.

Licenses are granted for 1s. a year, after inspection, to suitable foster-mothers, and the mother of the child is responsible for maintenance and clothing. Free medical attention is given; and inspectors, who are also trained nurses, visit these babies and advise as to their treatment. Another large class of illegitimate infants passed under the care of the Council by Act of Parliament in 1910, viz., those living with their own relatives in unlicensed homes. A high death rate was also the cause of this legislation. They are now visited by the Council's inspectors in the same way as those in foster homes. There were 1,637 children under the Council's supervision in licensed and unlicensed homes in 1913, and the death rate amongst them was 1·89. Medical attention can be had from a departmental doctor at a charge of 1s. per month per child. In all cases the foster-mother receives from the inspector an admirable pamphlet of instructions as to the feeding and care of infants, including a properly graduated diet table, and a weight card, on which the child's weight should be entered fortnightly. The card is taken to the doctor at each visit, and he enters upon it any special orders for diet or treatment. Foster-mothers who live in or near the city have the further advantage of the help and teaching provided in an excellent Mothers' School. Previous to 1910 the mortality amongst these illegitimate children boarded with relatives without supervision was 45 per cent. In 1913 the death rate amongst the same children and others of the same class under the Council's care was between 3 per cent. and 4 per cent. The figures speak for themselves of the importance and value of the work.

EDUCATION.

THE STATE SYSTEM.

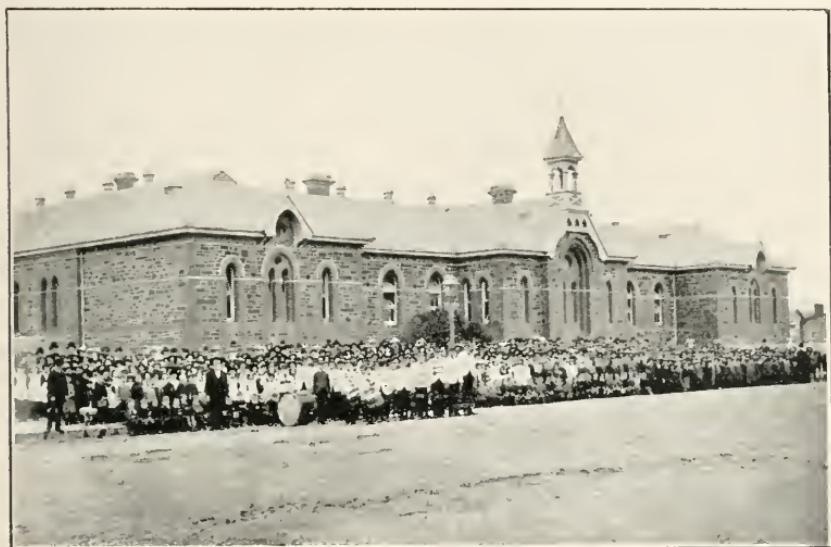
DURING the pioneer days there were no public schools, and little attention was devoted to the training of the young. Towards the end of the forties a capitation grant was paid out of the State funds to the few private schools then in existence, but the scheme did not work well. "The pilgrim fathers" had no toleration for anything that looked like "State Aid to Religion." Five years later the Government assumed direct control of primary education, and early in 1852 a Central Board of Education was created—(1) To establish schools, or recognise such schools as were then in existence, in which good secular instruction, based on Christian principles, but free from sectarian difference of belief or opinion, should be imparted. (2) To grant licences to teachers, and to pay them out of State revenues salaries ranging from £40 to £100 per annum in augmentation of the fees paid by the parents of the children. (3) To appoint inspectors, who should visit the schools and make reports to the Central Board on the character of the instruction given; and (4) to recommend the Colonial Government to give grants-in-aid of buildings erected by local subscriptions up to an amount not exceeding £200 per school. The next important step was taken in 1875, when the management of public schools was given to a Council of Education under the presidency of a paid officer. A wise choice was made in selecting for this responsible post Mr. John Anderson Hartley, B.A., B.Sc. (Lond.), at that time head master of Prince Alfred College. Mr. Hartley is regarded as having been the father of the educational system of South Australia. For over 20 years he controlled the destinies of the department, exercising a noble influence on the childlife of the State.

The Council of Education was superseded by direct management by Mr. Hartley as Inspector-General in January, 1878, and on his death in 1896, the control was vested in a Board of Inspectors. In July, 1902, the Board was abolished and an Inspector-General was again appointed. In 1906 a Director of Education was chosen to command the department.

THE PRIMARY SYSTEM.

Prior to 1891 the State system of primary education was secular and compulsory, but not free. The Act of 1875 was, however, further amended in 1891, and as from January, 1892, this Act provided that "no

fee shall be payable by any parent to the Minister or to any teacher of a public school established under the provisions of the Education Act, 1875, for the education of any child in any such school." This Act further provided that in the case of children between the ages of 9 and 13 years the compulsory distance should be increased from two to three miles. To satisfy the compulsory requirements of the Act, each child in the State between the ages of 7 and 13 years, residing within the compulsory radius, must attend an efficient school for at least 35 days each quarter. Legislation was passed in 1905 by which the compulsory attendance was increased to eight half-days out of every 10 for children living in, or within one mile of, any corporate town.



A Typical Public School in South Australia.

TRAINING TEACHERS.

For the benefit of those desirous of devoting their lives to teaching, a Training College was established in 1876. All students were non-resident. In 1900 a new scheme of training was introduced. The Council of the University of Adelaide, having received a large bequest under the will of the late Sir Thomas Elder, made a generous offer to the Minister of Education, by which those in training for teachers would be allowed a one, two, or three years' course of study for the B.A. or B.Sc. Degree, free of cost. It was therefore arranged that candidates after showing a capability to teach (as monitors) should be admitted to the Adelaide High School. Here they study for three years to pass the Junior and Senior Public

Examinations (the latter being the matriculation standard of the University). After this they spend one year teaching in the larger public schools, and then enter the Teachers' Training College for another year, and possibly two years. During the term of training students receive a maintenance allowance of from £40 to £80, according to circumstances.

PRESENT CONDITIONS.

The State primary schools are of two kinds—public schools, under fully trained teachers, and provisional schools, taught by partially-trained teachers. The latter, however, are required to undergo a special examination, and to serve in a special school for six months. The public schools are divided into eight classes, and the salaries of male head teachers range from £195 in a Class VIII. school, with an average attendance of 20 to 40, to £475 per annum in a Class IA. school, with an average attendance of 800 or over.

The salaries of female head teachers range from £140 to £170. A lady cannot be appointed as head teacher to a school in any class above VII.

The salaries of male assistants begin at £120 and rise by annual increments to £210. Male chief assistants receive further yearly increments to a maximum of £240. Female assistants' salaries, beginning at £100, rise to £156, with a maximum of £200 for women chief assistants.

The course of study and the standard of examination are exactly the same in both public and provisional schools. A strict supervision is kept upon the daily working of the schools by means of a staff of inspectors. Districts are allotted, and the inspectors pay periodical visits, subjecting the classes to a critical examination and allotting merit marks which affect both teachers and scholars.

The curriculum is of an elastic character to permit of some display of individuality on the part of teachers. The regulations fix the course of instruction; but while the main line of subjects is defined in order to secure uniformity of work in all grades of primary schools, variation is permitted under the approval of the district inspectors. Head teachers also exercise discretion within the limits of the general organisation, but greater freedom is allowed in the teaching of such subjects as elementary science, horticulture, agriculture, and other various kinds of manual work. The following is a summary of the curriculum :—1. English—Clear and distinct articulation, correct speech, reading, writing, spelling, oral and written composition, grammar, poetry. 2. Mathematics—Arithmetic, mensuration, algebra, geometry. 3. Civics and Morals—History, conduct, citizenship. 4. Handwork—Drawing, brushwork, “Kindergarten” exercises, modelling

in clay, cardboard, woodwork, and needlework. 5. Music and Physical Culture—Singing, breathing, physical exercises, drill. 6. Nature Knowledge—Observation lessons, nature study (whenever possible allied with gardening), geography, elementary science (in Classes V. and VI.).

PHYSICAL CULTURE.

Considerable attention is devoted to physical culture. Drill and physical exercises are part of the curriculum. Swimming is taught by experts. To the accompaniment of their own drum and fife bands the State school children can "march past" or engage in military manœuvring with the accuracy and precision of well-trained soldiers. Sewing, drawing, and vocal music are taught in all State schools. In the larger centres instruction in cookery and household management is given to the girls, and the boys are trained in the various branches of manual work.

OBSERVATION SCHOOL.

To assist in the training of teachers an Observation School has been established in Adelaide. This is an elementary school which carries on the ordinary work of the public schools; but it has been provided with a special staff, both as regards numbers and efficiency.

The work of training of teachers carried on in this establishment has two phases—(a) that connected with the junior teacher system and the students of the Teachers' Training College; (b) the special training during short periods of young people who are to take charge of the small rural (provisional) schools.

(a) The junior teachers who are studying at the Adelaide High School attend at the Observation School twice a week to observe the methods of teaching in use, and to receive from the head master instruction in the art of teaching. The students at the Teachers' Training College also spend certain periods of the year at the school. They take the classes and show their capacity as teachers, under the supervision of the regular staff of the school, and in the presence of inspectors specially detailed for this work.

(b) The provisional teachers who pass through the Observation School are of two types. There are some whose education is accepted as sufficient for the work which has to be done in the small country school, but who have little or no knowledge of how to manage to carry on such a school effectively. These young people are allowed to attend until they can satisfy the head master that they are able to teach the classes, keep the records, and manage a school of this type.

A model country school has been erected in the grounds of the Observation School, and it is worked under conditions which approximate as nearly as possible to those of the schools to which the trainee will be sent. An expert and experienced teacher is the head of this little establishment, and supervises the work of each one who goes there. Every trainee for a provisional school is required to spend at least a fortnight in this little school.

The second class of provisional teachers is probably not quite so well equipped in the matter of scholarship on entry, and these young people are required to spend six months in the school. They are taught in classes in the special subjects they will have to teach when they leave, in addition to passing through the practical branches of the work just outlined. At the close of the term they undergo an examination, and if successful they are placed in schools for one year on probation, after which, if they study and succeed as teachers, the way lies open to any position in the service.

A maintenance allowance of 15s. per week for women, and £1 per week for men, supports them while carrying out their studies during this six months. In return they bind themselves to work for two years in any position to which they may be appointed.

STATISTICS SHOWING PROGRESS OF PRIMARY EDUCATION FROM JANUARY 1ST, 1901, TO DECEMBER 31ST, 1912.

Year.		Number of Schools.	Number of Teachers.	Number of Children Instructed.	Average Attendances.	Net Cost to State.
1876	..	281	550	25,889	13,622	52,210
1901	..	706	1,331	63,183	43,789	149,795
1902	..	716	1,351	62,962	42,690	149,393
1903	..	715	1,320	61,977	42,752	145,626
1904	..	715	1,332	60,879	42,234	146,031
1905	..	722	1,420	59,026	41,807	149,183
1906	..	708	1,426	57,270	40,489	150,542
1907	..	707	1,389	54,560	37,861	150,157
1908	..	690	1,438	54,157	38,193	152,950
1909	..	722	1,411	53,748	38,255	156,622
1910	..	*713	1,429	52,929	37,549	167,426
1911	..	*717	1,407	53,494	37,427	184,033
1912	..	*749	1,584	55,498	38,988	196,143

* Not including High Schools.

*Statistics Showing Progress of Primary Education from January 1st. 1901,
to December 31st, 1912.—continued.*

Year.	Cost to Parents. Fees.	Total Cost.	Cost per Child Instructed.			Cost per Child in Average Attendance.
			£	s.	d.	
1876	12,208	64,418	2	9	9
1901	—	149,795	2	7	4 $\frac{3}{4}$
1902	—	149,393	2	7	5 $\frac{1}{4}$
1903	—	145,626	2	7	0
1904	—	146,031	2	7	11 $\frac{1}{2}$
1905	—	149,183	2	10	6 $\frac{1}{2}$
1906	—	150,542	2	12	6 $\frac{3}{4}$
1907	—	150,157	2	15	0 $\frac{1}{2}$
1908	—	152,950	2	16	5 $\frac{3}{4}$
1909	—	156,622	2	18	3 $\frac{1}{4}$
1910	—	167,426	3	3	3 $\frac{1}{4}$
1911	—	184,033	3	8	1 $\frac{3}{4}$
1912	—	196,143	3	10	8 $\frac{1}{4}$

+ In these years an epidemic of measles caused the average attendance to be very low.

SCHOOLS IN OPERATION.

The number of schools in operation during the years 1911 and 1912 is shown in the following table :—

		1911.	1912.
High School (Adelaide)	.. ..	.. 1	.. 1
District High Schools	.. ..	.. 18	.. 18
Public Schools	.. ..	.. 283	.. 288
Provisional Schools	.. ..	.. 412	.. 439
Half-time Schools	.. ..	.. 22	.. 22
 Totals	.. ..	<hr/> .. <u>736</u>	<hr/> .. <u>768</u>

SCHOOL ATTENDANCE.

The total number of children taught in primary schools under the Department during the year 1912 was 61,481. Deducting from this total the number of those who attended more than one school during that period, viz., 5,983, the number of individual pupils in attendance is seen to be 55,498. This represents an increase of 2,004 on the number under instruction during 1911. To this number should be added 2,775 pupils who attended at the Adelaide High School and the various District High Schools. The daily average attendance for the year in all schools was 38,988, an increase of 1,561 on the record of the previous year. The most satisfactory attendance was registered in the month of March, when the average reached 85.6 per cent. of the enrolment.

Owing to the prevalence of infectious diseases, the attendance fluctuated somewhat during the year, reaching its lowest limit in December, when the daily average attendance was only 72·7 per cent. of the number on the rolls.

From the annual statistics furnished by the teachers the following returns have been compiled :—

	Gross Number under Instruction during 1912.	Number who Attended More than One School during 1912.	Net Number of Children Instructed during 1912.	Net Number Instructed during 1911	Increase.	Decrease.
Public schools ..	51,602	5,184	46,418	44,405	2,013	—
Provisional schools ..	9,879	799	9,080	9,089	—	9
Totals ..	61,481	5,983	55,498	53,494	2,013	9

The average *daily* attendance was—in public schools 33,364, and in provisional schools 5,624, making a total of 38,988.

The following table gives the ages of the children on the registers of the Primary Schools for the year 1912 :—

Quarters.	Under 7.	7 to 13.	13 and over.	Totals.
March	7,396	39,152	4,187	50,735
June	7,147	39,236	4,617	51,000
September	8,366	38,388	4,727	51,481
December	6,994	39,192	4,578	50,764

The ages of the children on the registers of the Secondary Schools for 1912 are shown in the following table :—

Quarters.	Under 13.	13 and over.	Totals.
March	316	1,682	1,998
June	233	1,630	1,863
September	447	1,898	2,345
December	448	2,019	2,467

COMPULSORY CLAUSES OF THE ACT.

The following table shows the proportion of children who complied with the requirements of the Education Acts by attending thirty-five days in the quarter, and also the proportion of unsatisfactory cases. It should not be forgotten that the number of children subject to compulsion is not the same

as the number in attendance between the ages of 7 and 13. A child may live beyond the compulsory distance from the school; he may be exempted on the ground of ill-health; or he may have obtained the Inspector's certificate, which frees him from the liability to attend school:—

	1911.			
	First Quarter.	Second Quarter.	Third Quarter.	Fourth Quarter.
Children in attendance, subject to compulsion	33,347	33,459	33,301	32,581
Attended 35 days .. per cent.	81.07	83.39	78.20	72.84
Satisfactory reasons given for not attending per cent.	17.80	15.90	21.33	26.52
Cases of neglect per cent.	1.13	0.70	0.37	0.89

	1912.			
	First Quarter.	Second Quarter.	Third Quarter.	Fourth Quarter.
Children in attendance, subject to compulsion	33,658	34,432	34,398	34,087
Attended 35 days .. per cent.	80.92	87.22	87.15	82.95
Satisfactory reasons given for not attending per cent.	18.09	12.28	12.42	16.29
Cases of neglect per cent.	0.99	0.50	0.43	0.76

DOMESTIC SUBJECTS FOR GIRLS.

The reconstruction and furnishing of the Domestic Arts Centre at Norwood was completed during the year 1910, and the work for which the institution has been provided is now proceeding. Though the building is not on a large scale, ample provision has been made for giving instruction in cookery, laundry work, household management, and hygiene. It contains a large cookery-room (with provision for class teaching, demonstration, and practice), dining-room, model bedroom, and kitchen, in addition to quarters for the mistress in charge.

A number of teachers are at present undergoing a course of training to fit them for taking charge of centres in various parts of the State. Girls from the Norwood High School (which receives pupils from all the eastern suburbs) now receive regular instruction in subjects which must prove of great value to them in later years. In South Australia we have been somewhat tardy in recognizing the importance to the community of teaching our girls those things which they need if they are to become capable home-makers, but a

promising beginning has been made at Norwood. It is intended to extend and develop this important branch of our work as rapidly as possible, and to extend its benefits as widely as circumstances will permit.

SCHOOLS IN NEW SETTLEMENTS.

Of late, considerable trouble has been experienced in providing school accommodation for the children of settlers in newly-opened areas. In some places the Department has tried to meet the difficulty by providing large tents as temporary substitutes for schools. Although they have been made as comfortable as possible, the tents have not proved to be altogether satisfactory. Owing to sudden changes in temperature, strong winds, and dust storms, the tents are very often uncomfortable, and school work is carried on under difficulties. An attempt is to be made to provide temporary schools of a more satisfactory nature, which can be quickly constructed and erected where required, and easily removed to another locality when necessary. This step, it is hoped, will remove one of the very serious disadvantages which settlers in outlying districts have suffered in the past.

TEACHERS.

The following table shows the number of teachers of all classes employed at the close of the two years 1911 and 1912:—

Rank.	1911.			1912.		
	Male.	F. male.	Total.	Male.	Female.	Total.
Head Masters	224	29	253	13	—	13
Head Mistress				—	1	1
Head Teachers				226	31	257
Chief Assistants	23	11	34	13	19	32
Assistant in charge D.H.S. ..	1	23	24	18	1	19
Assists Primary Schools ..	52	233	285	33	197	230
Assists Secondary Schools ..				26	36	62
Acting Assistants	6	77	83	4	86	90
Provisional Assistants	9	65	74	6	95	101
Junior Teachers	16	53	69	18	48	66
Senior Monitors	21	66	87	—	11	11
Monitors				23	91	114
Provisional Teachers	56	343	399	62	375	437
<i>Locum tenens</i> for Head Teachers ..	21	11	32	21	5	26
<i>Locum tenens</i> for Provisional Teachers	—	7	7	—	14	14
Teachers of Needlework (employed part time only)	428	895	1,323	463	1,010	1,473
Grand totals	428	979	1,477	463	1,121	1,584

INSPECTION.

During the year, 699 schools were fully examined in detail by the Inspectors. The total number of children presented was 42,541, against 38,114 in 1911.

Out of 5,354 children examined in the Fourth Class, 2,303 succeeded in passing the standard fixed by the Education Act for exemption from further attendance at school; and out of 3,958 children examined in the Fifth Class, 1,904 obtained certificates.

It is the practice to classify the schools in six divisions, according to the results of the examination, after due allowance has been made for exceptional circumstances. The following is the result:—

	Public.		Provisional.	
	1911.	1912.	1911.	1912.
	282	283	408	416
Number of schools	Per cent.	Per cent.	Per cent.	Per cent.
Class A	25.88	28.62	6.12	5.53
" B	30.85	34.28	15.93	17.07
" C	23.05	20.14	25.00	25.00
" D	12.05	10.95	22.30	20.92
" E	4.61	4.59	14.95	13.07
" F	2.84	1.07	6.86	8.89

Thirty-eight schools were not classified.

SCHOLARSHIPS.

Under existing regulations provision is made for the following scholarships:—

(A) Eight Public Exhibitions (four for boys and four for girls), open to any girls and boys who have been *bona fide* residents of the State of South Australia for at least two years immediately preceding the 31st of December of the year in which the competitive examination is held. They are tenable for three years at any approved school or college, and provide free tuition and books, with an allowance of £22 per annum in those cases where the home of the candidate is distant from the school at which he or she elects to attend.

(B) Forty Exhibitions, tenable for three years at the Adelaide High School or any District High School, are offered for competition among children of 13 years of age who have been attending a primary school under Government control. A maintenance allowance of £22 per annum is given in addition to free tuition. The examination for deciding these scholarships is the Fifth Class standard of the public schools, with the addition of a small textbook on Health and Hygiene.

These scholarships are intended to help those children, whose homes are distant from a District High School, to obtain the advantages offered by those schools.

(C) Senior Exhibitions.—There are eight of these (each worth £40 per annum), tenable for two years at the Adelaide High School. They are open to all country pupils attending any High School under Government control, four each worth £20 per annum, open to pupils attending the Adelaide High and Suburban District High Schools, and are awarded on the results of the Senior Public Examination. The winners are afforded an opportunity to prepare for the competition for Government Bursaries, which provide a course of four years' duration at the University.

(D) Government Bursaries.—Twelve of these are offered annually. Six are reserved for pupils of the Government High Schools. The remaining six are open for competition amongst any young people who have been resident in South Australia for at least one year prior to the deciding examination. The Bursaries are tenable at the Adelaide University for four years (or five years in the case of students in medicine), and admit successful candidates to the Schools of Arts, Science, Medicine, or Law. They exempt the holders from payment of fees at the University or the Roseworthy College, and in addition provide for the payment of a maintenance allowance of from £20 to £40 per annum.

(E) University Studentships (for evening students).—Nine studentships are offered for science and engineering, and 13 for other courses. Ten scholarships cover fees, text-books, and material.

FINANCE.

Comparison of the expenditure on Primary Schools for 1911 with that of 1912 shows an increase during the latter year of £12,451. This is accounted for mainly by the increases of salaries to public and provisional teachers, and the introduction of the system of training of provisional teacher candidates.

Upon secondary education the expenditure amounted to £22,578 13s. 2d., which includes the cost of maintenance of the School of Art, the Adelaide High School, eighteen District High Schools, as well as the cost of scholarships. This is an increase of £5,754 1s. 11d. No fees are charged at High Schools.

Sites, buildings, improvements, and repairs show an increase of £5,274 6s. 9d.

TRAINING OF PUBLIC SCHOOL TEACHERS.

The training course for public school teachers at present extends over a period of from six to eight years. Boys and girls of good character, mental

vigor, and physical health, who are at least 14 years of age, and who show satisfactory promise of teaching ability, are admitted to the Adelaide High School for a training period of three years. Most of this time is devoted to the acquirement of a sound general education; but courses in the principles of instruction and class management are likewise given, and opportunities are afforded for practice in actual teaching.

During the next year the young people are engaged in teaching work in public schools (usually the schools from which they came before entering the High School). They are thus enabled to acquire very fair skill and a direct knowledge of the basal problems of education. At the end of this period the junior teachers are eligible for admission to the University Training College, provided they have matriculated.



Prince Alfred College, Adelaide.

The Training College courses have been planned with a view to developing in the students a broader and more cultured outlook upon life generally, but likewise a deeper insight into educational problems, and greater skill in the technique of teaching itself. The close connection of the Training College with the University enables the students to attend a variety of lectures in Arts and in Science. The acquisition of professional knowledge is provided for by courses of lectures on school management generally, and on methods of instruction in all ordinary school subjects. In addition, opportunities are afforded in city and suburban schools for practice in actual teaching.

There are distinct courses of training to prepare teachers for the work in infant and primary schools. Each of these extends over one year. Additional courses are provided for those who will become teachers in high schools.

The course leading to the infant teachers' certificate is open to those students who show special aptitude for dealing with very young children. The course includes instruction in the following subjects:—One or more University subjects (including education), English literature, psychology, hygiene, physical culture, drawing, modelling, and brushwork, music (instrumental and vocal), elocution, nature study, civics, sewing, and infant and lower primary school management and methods of instruction (theory and practice).

The alternative course, leading to the primary teachers' certificate, is similar to the above, except that the lectures on class management and instruction and the actual teaching have reference to the work of primary schools.

Students who have completed their primary teachers' course, and have shown special ability both as students and as teachers, are granted a second, and in special cases a third, year of training. During this time they devote the greater part of their time to University studies in order to acquire the deeper knowledge of special subjects (classics, science, commerce, &c.) required for high school work; but instruction in school management and practice in teaching are continued. These students are thus able to complete a considerable part of the work required for the University diploma in education.

THE HIGH SCHOOLS.

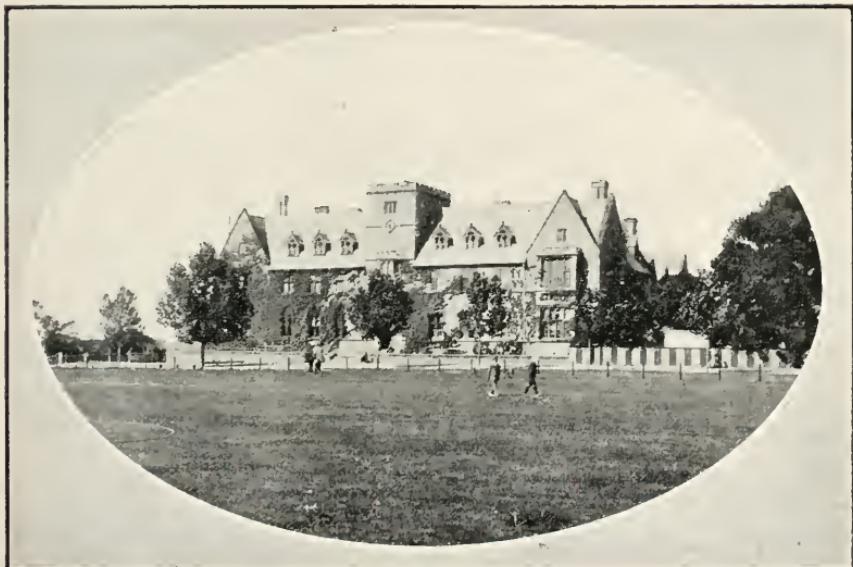
The Adelaide High School had 721 pupils on its roll for the year 1912. Of this number, 97 were young student teachers, 319 were improving their general education prior to beginning work, 205 were studying for the University Public Examinations, while 100 were taking a commercial course to prepare them for business pursuits. It is intended to provide a course of instruction in domestic subjects for the girls as soon as rooms can be made ready for the purpose.

Forty-four students passed the Higher Public Examination in from one to five subjects, seven passed the State Civil Service Examination, and four the Commonwealth Public Service Examination.

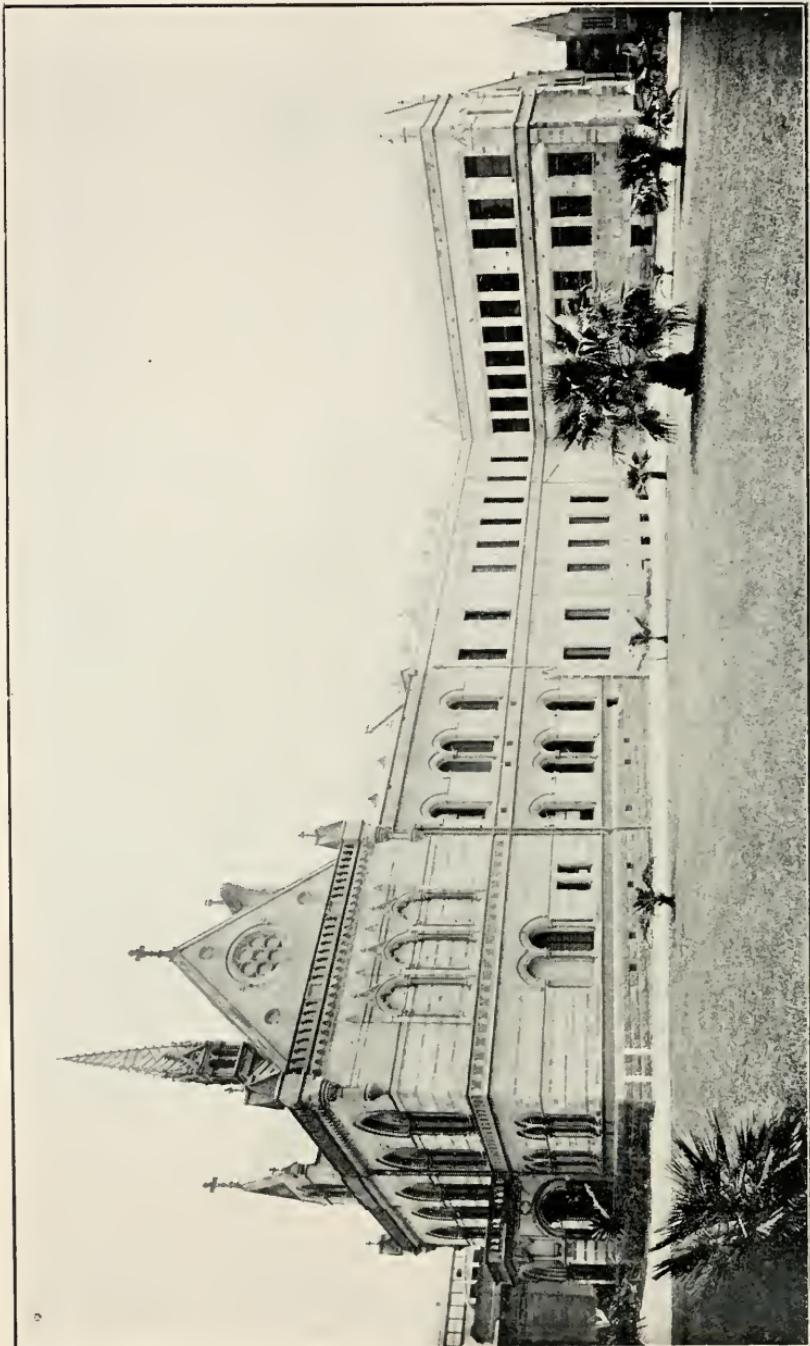
Eighteen District High Schools provided for ten suburban and country districts, with a total attendance of 2,054.

In the University Public Examinations for 1912 the following results were obtained and certificates awarded :—

	Adelaide High School.	Country and Suburban.
Primary	65	237
Junior	61	76
Senior	44	8
Junior Commercial	6	7
Other Scholarships, &c.	—	49



St. Peter's College, Adelaide.



University of Adelaide.
The University (main building) from east side.

THE UNIVERSITY OF ADELAIDE.

THE University of Adelaide was established by Act of Parliament in the year 1874, and Royal Letters Patent were granted in 1881. The preamble to the Act of Incorporation states—"Whereas it is expedient to promote sound learning in the Province of South Australia, and with that intent to establish and incorporate and endow an University at Adelaide, open to all classes and denominations of Her Majesty's subjects . . . an University, consisting of a Council and Senate, shall be established at Adelaide." Letters Patent of March 22nd, 1881, gave the University power to grant Degrees in Arts (Bachelor and Master), Medicine (Bachelor and Doctor), Laws (Bachelor and Doctor), Science (Bachelor and Doctor), Music (Bachelor and Doctor), and provided that these degrees "shall be recognised as academic distinctions and rewards of merit, and be entitled to rank, precedence, and consideration in Our United Kingdom and in Our Colonies and Possessions throughout the world, as fully as if the said degrees had been granted by any University of Our said United Kingdom."

A further Act in 1888 empowered the University to grant Degrees in Surgery, viz., Bachelor and Master. In 1911 the Act was further amended, and power granted to confer Degrees in Engineering, viz., Bachelor and Master.

Under the Letters Patent, and Amending Acts passed in 1879 and 1880, women may obtain any of the above-mentioned degrees. The University of Adelaide was the first of the Australian Universities to provide for granting degrees for women.

A supplementary Royal Charter was granted during the year 1913 by His Majesty the King, in respect of the Degrees of Bachelor and Master of Engineering and Bachelor and Master of Surgery. This charter entitles those degrees to rank as do the other degrees granted by the University, and covered by the former charter, as fully as if they had been granted by any University in the United Kingdom.

Endowments.—The University has received, in round figures, £139,000 in endowments from private citizens. This sum is invested in approved interest-producing securities.

During 1913 two patriotic citizens promised further endowments to the University.

Mr. R. Barr Smith, through whose munificence the University Library has been built up to its present stage of efficiency, offered £10,000 to provide a Common Hall, Refectory, &c., for the students, on condition that the Government would subsidise the donation pound for pound and also allocate

to and vest in the University the additional ground for which the Council had made request. The Government generously agreed to the subsidy, and when the allocation of the land has been made the necessary buildings will be erected.

Mr. Peter Waite offered, subject to life interests for himself and Mrs. Waite, to the University his "Urrbrae" estate at Mitcham of 134 acres, for the following purposes :—

1. The eastern portion, about 67 acres, with the mansion and other buildings thereon, to be used for University work in Agriculture, Botany, Entomology, Horticulture, and Forestry.
2. The other half to be a Public Park under the control of the University, with permission to use 10 or 15 acres for a Student's Sports Ground if thought desirable.

The Council gratefully accepted Mr. Waite's munificent offer. A condition of the gift—which the Government has assented to—is that no succession duty shall be payable by the University in respect of it.

The land (five acres in the city of Adelaide) upon which the University buildings stand was granted by Parliament; also 50,000 acres of country lands for revenue purposes. The Government recently purchased the country lands from the University for the sum of £40,000. The working capital of the University is therefore £178,000.

In accordance with the Act of Incorporation, the Government pay an annual subsidy of 5 per cent. on all permanent endowments. In future, under the Act of 1911, this subsidy will be increased by £4,000.

The governing bodies are (*a*) the Council, (*b*) the Senate, and (*c*) Committees, Faculties, and Boards.

The academic year covers nine months, but between March and December there are two vacations of a fortnight each. The first term begins on the second Tuesday in March, and the third term ends on the second Tuesday in December. For the Elder Conservatorium four terms are provided, and the academic year begins the last week in February.

The teaching staff of the University consists of 11 Professors and 32 Lecturers and Assistant Lecturers. In the School of Music there are a Professor and 13 teachers of special subjects in connection with the Conservatorium.

Before admission, all students must have attained the age of 16 years. Those who intend to graduate must pass the Senior Public (entrance) Examination, and must be formally matriculated. Non-graduating students may attend lectures without complying with either of the above-mentioned conditions.

Attendance at lectures is required, but the Council have power, in special cases, to grant partial exemption.

DEGREES AND DIPLOMAS.

(a) *Arts.*

B.A.—For the Degree of Bachelor of Arts students are required to attend lectures and pass examinations for at least three years.

The minimum number of subjects a student is required to pass for the Ordinary Degree is six, and there is a wide choice. Some subjects may be passed in one year, others spread over two years.

Students may take either the Ordinary or the Honors Degree. For the latter, a student may specialise in one department, viz., Classics, History, Philosophy, or Mathematics. The work of these is of a higher standard than for the Ordinary Degree.

Greek is a compulsory subject for the Arts course only.

M.A.—Graduates who have taken the B.A. Degree may obtain either the Ordinary or Honors Degree of M.A. after the expiration of two years. The Ordinary Degree may be obtained by attendance at lectures and passing examinations in three subjects other than those taken for the Bachelor's Degree. For the Honors Degree a candidate must have obtained the Honors Degree of B.A. in the department of study in which he desires to obtain the Master's Degree. Attendance at lectures is not compulsory, but in Classics, History, or Philosophy the candidate is required to do original work, in addition to passing the examination.

(b) *Science.*

B.Sc.—The conditions for the Ordinary or Honors Degree of B.Sc. are very similar to those for the B.A. course, with the addition of considerable laboratory work.

D.Sc.—A Bachelor of Science may, three years after graduation, proceed to the Degree of Doctor of Science. Every candidate must give satisfactory evidence of scholarship and power of original research, and must submit a thesis in some branch of Science approved by the Faculty. He may also be required to pass an examination.

B.E.—To obtain the degree, every candidate must attend lectures regularly and pass examinations in the whole of the subjects prescribed for one of the courses for the Diploma in Applied Science, and must present evidence to the satisfaction of the Council of having had 12 months' practical experience, not necessarily consecutive, in work appropriate to the course he has followed.

M.E.—A Bachelor of Engineering may, two years after graduation, proceed to the Degree of Master of Engineering. Every candidate must give satisfactory evidence that he has had at least three years' practical experience

in engineering work, and must submit either an original engineering design or a thesis setting forth the results of an original scientific investigation made by him in some subject allied to engineering. He may also be required to pass an examination.

(c) *Applied Science.*

In conjunction with the South Australian School of Mines and Industries, the University provides for a Diploma in Applied Science in addition to the B.E. Degree. Candidates may obtain the Diploma in Mining, Metallurgy, Electrical Engineering, or Mechanical Engineering. The courses extend over four academic years' attendance at lectures and examinations. Candidates are also required to obtain at least 12 months' practical experience, not necessarily consecutive, in work appropriate to the course followed. Graduates obtain the B.E. Degree and Diploma of the University, and the Fellowship of the School of Mines and Industries.

In conjunction with the Government Agricultural College, provision is made for students to obtain the Degree of Bachelor of Science with Agriculture. Part of the course is taken at the University and part at the Agricultural College.

(d) *Law.*

LL.B.—Before commencing the course for the Degree of Bachelor of Laws, students must have passed the Senior Public Examination or have graduated in Arts. The subjects for the degree are divided into two classes, distinguished as ordinary and special subjects.

No student may at any annual examination present himself for examination in more than three subjects, save by the special permission of the Faculty of Laws. The course is usually concluded in four years.

LL.D.—A Bachelor of Laws may proceed to the Degree of Doctor of Laws after three years.

Every candidate is required to present a thesis of sufficient merit, exhibiting powers of original research on some branch or subject of law.

The candidate may be examined orally, or by written questions, in the subject matter of his thesis.

(e) *Medicine and Surgery.*

M.B. and B.S.—Candidates for the Degrees of Bachelor of Medicine and Bachelor of Surgery are required, before entering upon the course, to pass the Senior Public Examination and a preliminary examination in Elementary Biology, Chemistry, and Physics. Candidates must then attend lectures for five years and pass the examinations proper to each year. During the third, fourth, and fifth years of the course they are required to attend the Medical and Surgical practice of the Adelaide Hospital, the Children's Hospital,

and the Hospitals for the Insane. They are also required to act as clinical and surgical clerks, to attend at least 20 cases of midwifery, and to receive instruction in vaccination, anaesthesia, and dentistry.

M.D. and M.S.—No candidate is eligible for the Degrees of Doctor of Medicine or Master of Surgery until the third year after his admission to the Degrees of Bachelor of Medicine and Bachelor of Surgery, except under special conditions.

Subjects for examination are prescribed, but either degree may be obtained for an original thesis embodying the result of independent research, if deemed by the examiners of sufficient merit. Candidates may be required to pass an examination in addition to presenting a thesis.

(f) Music.

Mus. Bac.—A candidate for the degree of Bachelor of Music must attend lectures for three years and pass the examination proper to each year. He must also compose an exercise to be approved by the examiners, or satisfy them of his ability as an executant on the pianoforte, organ, violin, or other instrument, or in singing.

Mus. Doc.—Candidates may obtain the degree of Doctor of Music three years after graduation as Bachelors of Music. They are required to compose an original exercise, to be approved by the examiners, and to pass an examination in prescribed subjects.

In connection with the School of Music a Conservatorium providing a complete system of instruction in both theory and practice of Music has been established. The course of instruction is so arranged that students may be prepared for a professional course or may attend for the study of a single subject only.

Diploma A.M.U.A.—Students of the Conservatorium may obtain the Diploma of Associate in Music of the University of Adelaide by attending lectures and receiving instruction in singing or instrumental playing for three years, and passing the examination proper to each year.

(g) Commercial Course.

A.C.U.A.—This University was the first in Australia to provide a Commercial Course. Candidates may obtain the Diploma of Associate in Commerce of the University of Adelaide by attending lectures and passing examinations in—

Business Practice, Accountancy, Commercial Law, Economics and
Commercial History, Banking and Exchange, and Commercial
Geography and Technology.

No entrance examination is required, lectures are all given in the evening, and the course takes at least four years.

(h) Admissions ad eundem gradum and statum.

Any graduate of another University recognised by the University of Adelaide may be admitted *ad eundem gradum*. The University recognises all Universities of the British Empire to which Royal Charter or Letters Patent have been granted. No other University is recognised, except by special resolution of the Council in each case.

Persons who have completed the whole or part of their undergraduate course in any University or College recognised by the University of Adelaide may be admitted *ad eundem statum*.

External Examiners are appointed in all cases for the Degree of Doctor or Master; in all cases for Honors Degrees; in all subjects in the Law course; in all final subjects in the Arts, Science, and Medical courses; in Technical subjects; and in nearly all the subjects of the fifth year of the M.B. Degree. For the Degree of Bachelor of Music external examiners are appointed for the third year, for the original exercise, and for the final examination of an Executant.

Botany and Forestry.—A Professor of Botany has recently been appointed. He also acts as Consultant to the Government and undertakes the investigation of parasitic and other diseases of plants.

The Government having recently appointed an Instructor in Forestry, the Council have established a course in this subject, and included it in the curriculum for the B.Sc. Degree. A course for a Diploma in Forestry has also been provided.

Courses of Evening Lectures in Arts and Science subjects have been arranged to meet the requirements of students engaged in various occupations during the day, so that many who otherwise could not attend the University are enabled to proceed to a degree.

Extension Work.—In addition to the ordinary degree work, the members of the staff annually deliver courses of Extension Lectures at the University. The Professors also devote the May and August short vacations to giving courses of lectures in country centres. Requests from Western Australia for lectures are also acceded to when possible.

In order to bring the University into closer relationship with students in the country, a number of local centres have been established. The centres are controlled by local committees, and candidates, in many cases hundreds of miles from the city, are enabled to present themselves for the various public examinations held by the University. There are now 34 centres in active work throughout the State.

The public examinations conducted by the University are as under—

Primary and Junior (school examinations), Senior (entrance), Higher (by which candidates may take some of the elementary subjects of the B.A. or B.Sc. course), the Junior Commercial and Senior Commercial (preparatory to the course for the Diploma of Associate in Commerce). In addition to the above, a series of examinations in the Theory and in the Practice of Music are also held. The examinations are held in Adelaide, at the country centres, and in Western Australia.

In regard to the public examinations in music, the Australian Universities are endeavoring to form an Australian Board.

From 1906 to 1911 these examinations were held jointly by the Universities of Melbourne and Adelaide. The Universities of Queensland, Tasmania, and Western Australia having joined the federation the examinations will henceforth be held under the auspices of the five Universities. It is probable that the University of New Zealand will also join at an early date.

It is felt that the Universities, whose standard is unquestionably high, should have sole control of the public examinations in music for the extension of musical education within the Commonwealth rather than the Associated Board of the Royal Academy and Royal College of Music ; Trinity College, London ; the London College of Music ; and similar institutions which send out examiners each year.

Affiliated Institutions—

- (a) The Government Agricultural College, Roseworthy, South Australia ;
- (b) The Technical School, Perth, Western Australia.

The teaching in the Agricultural College in Agriculture, Viticulture, &c., is accepted as part of the University course for the Degree of Bachelor of Science with Agriculture.

The teaching in Chemistry, Physics, Mathematics, &c., up to the standard of the Ordinary Degree of B.Sc., in the Technical School, Perth, is accepted, and students in the western State attend lectures there instead of coming to Adelaide.

State School Teachers.—Teachers in training at the Government Training College may attend lectures in certain subjects and take examinations at the University without payment of fees. Candidates at the Public Examinations who intend to enter that College, and subsequently the University, are also excused payment of the ordinary fees.

Recognition of University by other bodies—

(a) The Universities of Oxford and Cambridge.

The University is affiliated to the Universities of Oxford and Cambridge. Matriculated students of the University of Adelaide who have completed therein two academical years of study, and have passed the first and second annual examinations for the Degree of Bachelor of Arts, Science, Laws, or Medicine, are entitled to be admitted to the privileges of affiliation.

(b) The Institution of Civil Engineers, London.

This Institution recognises the Senior Public Examination of the University as exempting from its own Studentship examination.

(c) The Institute of Chemistry of Great Britain and Ireland.

The Institute recognises the University as an institution for the training of candidates for the examinations of the Institute.

Royal Navy and British Army.—Under certain conditions, commissions in the Royal Navy and in the British Army are open to students of this University.

Buildings.—There are four groups of buildings on the University grounds—

(a) The original building, used now mainly for the Arts School, which cost (round figures only are given)	£39,000
(b) The Prince of Wales Building (Science)	11,000
(c) The Medical School	6,000
(d) The Elder Hall and the Elder Conservatorium of Music	18,000
(e) Additions to Library, provision of additional Lecture rooms for Arts, Botany, &c.	12,000
	£86,000

The Library.—The University has a Library containing about 29,000 volumes. A private citizen has made contributions amounting to £9,000 to enable the Council to purchase books.

Sir Samuel J. Way, Bart., is the Chancellor and Mr. C. R. Hodge the Registrar of the University.

SCHOOL OF MINES AND INDUSTRIES.

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PROMINENT amongst the public institutions of South Australia is its School of Mines and Industries. The place filled by this institution in the educational system of the State is one of vast importance. It represents in South Australia that branch of instruction now so vital to the welfare of a nation, viz., technical education ; for, as implied by its name it is a technical school as well as a school of mines. The scope of its activities is sufficiently wide to provide technical training for the youth of both sexes engaged in all classes of industrial and commercial pursuits, as well as complete courses in applied science adapted to the requirements of the thoroughly qualified mining, metallurgical, mechanical, or electrical engineer, and the architect. Since its inauguration, 25 years ago, the school has made remarkable and consistent progress. No small measure of its success is due to the zeal displayed by the members of its Council, and particularly by the Hon. Sir Langdon Bonython, who has been connected with the institution as president from its inception.

ORIGIN OF THE SCHOOL.

The establishment of the school was the result of the work of a board appointed by the Downer Government in 1886 to inquire into and report upon the best means to develop a general system of technical, including agricultural, education. The establishment of a school of mines having been made a portion of the Playford Government's policy, consideration of how this policy could best be carried out was referred to the Technical Education Board, which, in June, 1888, recommended that a School of Mines and Industries be established. This recommendation was adopted, classes were organised, and the work of the school began in March, 1889.

CONTROL OF THE SCHOOL.

The school is conducted under the authority of an Act of Parliament, assented to on February 17th, 1892. The Act provides for the management of the school by a council of 12 members, appointed annually by the Governor. The council has power to make regulations for the management of the affairs of the school, and for the granting of diplomas, certificates, &c.

GOVERNMENT GRANT AND FEES FOR INSTRUCTION.

The Government grant for maintenance of the school for the financial year 1913-14 was £8,062. Fees received from students during the year 1913 amounted to £2,560.

COURSES OF INSTRUCTION.

The School of Mines provides associate courses in mining, metallurgy, mechanical and electrical engineering, and architecture, and in conjunction with the University of Adelaide fellowship courses in mining, metallurgy, mechanical engineering, and electrical engineering. Since the inception of the school, 203 associate and 52 fellowship diplomas have been granted.

In addition to instruction in diploma departments, the school is the headquarters of all branches of technical education. The subjects now being taught comprise book-keeping, blacksmithing, building, drawing, carpentry, carriage drafting, cookery, dairying, electrical motor management, dress-making, fitting and turning, fruit culture, frenchpolishing, millinery, plumbing, pattern-making, printing, sanitary inspection, shorthand, sheet metal working, tailor's cutting, tailor's sewing, typewriting, veterinary science, wool-classing, and woodwork.

During 1913 instruction was given in 53 distinct subjects, and the number of individual students enrolled was 2,416.

A Preparatory Technical School is conducted in connection with the institution, its curriculum being designed with the object of preparing boys for the higher classes. No fees are charged, but an entrance qualification, based on the fifth class standard of the primary schools, is required. The Preparatory School is conducted by Mr. A. Ferguson, B.Sc., and staff.



School of Mines and Industries, Adelaide.

BUILDINGS.

The premises of the school are situated on North Terrace. The main building was completed in 1903 at a cost, exclusive of site, of £37,115, towards which Mr. George Brookman contributed £15,000. The metallurgical and chemical laboratories are contained in the Bonython Building, situated at the rear of the main structure, and completed in December, 1907. It was erected as a result of a contribution of £1,500 for a metallurgical laboratory made by the President of the School (Sir Langdon Bonython), this sum being subsidised by the Government to the extent of a further £4,000, in order that chemical and public assay laboratories might be provided in the new building. The wool-classing department, towards which the late Mr. J. H. Angas contributed £1,000, was opened in April, 1908. Other buildings are the mining annexe and the engineers' workshop.

DAVID MURRAY LIBRARY.

The school has a technical library, containing upwards of 4,000 volumes, which is the outcome of a gift of £2,000 by the late Mr. David Murray. An amount of £1,500 still remains unexpended.

PUBLIC ASSAY DEPARTMENT.

The public assay department of the State is conducted at the school, but is kept entirely separate from the instructional branches. The work includes various determinations required by the State Mines Department, and in order to foster the mining industry, minerals found on Crown lands not held under mineral lease are assayed for the public free of charge.



Residences, Mount Lofty.

PUBLIC LIBRARY, MUSEUM, AND ART GALLERY.

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THIS institution is governed by a board consisting of 14 members, five of whom are appointed by the Government, and nine of whom are elected as follows :—Three by the Institutes Association of South Australia, two by the Adelaide University, and one each by the Adelaide Circulating Library, the Royal Society of South Australia, the Royal Geographical Society of Australasia (S.A. Branch), and the South Australian Society of Arts.

The buildings in which the different collections are housed comprise—

The Institute Building, in which a copy of every South Australian newspaper and leading extra-State and oversea newspaper is filed. Here, also, is the fine Yorkgate Library, which is the property of the Royal Geographical Society, but is accessible to the public under certain conditions. The societies affiliated with the institution, viz., the Royal Society of South Australia, the Royal Geographical Society of Australasia (S.A. Branch), the South Australian Society of Arts, and the Astronomical Society of South Australia are housed in this building, as are also the Institutes Association of South Australia and the Adelaide Circulating Library. The last named is entirely separate and distinct from the Public Library, but its subscribers elect one of the members of the Board of Governors of the Public Library, Museum, and Art Gallery of South Australia. In the Institute Building is a lecture-room capable of seating over 300 people, and an episcope and projection lantern, which are there available, cause the room to be much sought after for lecture purposes. In this room is a collection of water-color paintings of Australian wild flowers.

The Public Library Building, first occupied in 1884, is a fine freestone building, containing about 90,000 volumes, covering all branches of literature, excepting law and medicine ; the Supreme Court and the University Libraries are expected to respond to the wants of the professions as regards such literature. The library is visited annually by over 100,000 people.

The Natural History Museum Building is visited annually by over 80,000 people, and is becoming increasingly popular. Its Australian ethnological collection is said to be the finest in the world, and the early completion of the eastern wing of the Public Library block will afford an opportunity for exhibiting these things more satisfactorily than is at present possible. The only specimen in existence of the skeleton of the *Diprotodon australis* is in this museum.

The Art Gallery Building contains a well selected collection of pictures of modern masters, and generally surprises the connoisseur who visits it. The gallery is at present being equipped with electric light, and it is proposed to throw it open to the public at night time as an experiment ; 1,381,250 persons have visited the gallery since it was first opened in 1900.

In the Art Museum are to be exhibited historical portraits, prints, and engravings, coins and medals, archaeological specimens. Some of these collections are exceptionally good—notably, the coins and medals, and the prints and engravings.



Almond Blossom.

The institution, of which Mr. W. J. Sowden is president, is supported by a Parliamentary vote, which, for 1913-14 amounted to £8,787. This has been quite inadequate, but through the generosity of such public spirited citizens as Sir Thomas Elder, Dr. Morgan Thomas, and Mr. David Murray, it has been possible for the different departments of the institution to maintain a steady progressive development. Thus in 1912-13, although the Parliamentary vote was only £8,487, the board expended £10,640 8s. 3d. Sir Thomas Elder bequeathed £25,000 for the purchase of pictures. Dr. Morgan Thomas bequeathed £65,000 for the benefit of the institution, and the board apportioned one-half of it to the Library and one-quarter each to the Natural History Museum and the Art Gallery. Mr. David Murray bequeathed £3,000 and his collection of prints and engravings for the formation of a National Prints and Engravings Collection. Mr. J. R. G. Adams is General Secretary.

POPULATION AND VITAL STATISTICS.

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THE growth of population has been steady and consistent—in keeping with industrial expansion. The total number of inhabitants in 1840, four years after the proclamation, was 14,600. During the next 10 years there was an increase to 63,700, while in the next decade the population doubled. By 1870 there had been a further increase to 183,797, while in 1880 the figures were 267,573, and in 1890, 314,195. The last census (1911) showed the total population of the State as 408,558.

The estimated population on December 31st, 1912, was 430,090; this showed an advance of 11,918 on the number at the beginning of the year, made up of 7,743 by excess of births, and 4,175 by excess of immigration. The following shows the estimated mean population of South Australia and metropolitan :—

Year	SOUTH AUSTRALIA.			METROPOLITAN (ADELAIDE AND SUBURBS).		
	Males.	Females.	Total.	Males.	Females.	Total.
1903	176,254	179,183	355,437	79,756	87,139	166,895
1904	176,586	180,382	356,968	80,875	88,522	169,397
1905	179,182	180,758	359,940	82,035	89,947	171,982
1906	182,334	180,776	363,110	83,121	91,317	174,438
1907	184,864	182,846	367,710	84,256	92,715	176,971
1908	190,524	187,470	377,994	85,504	94,289	179,793
1909	196,553	191,886	388,439	86,868	95,971	182,839
1910	201,344	196,356	397,700	88,237	97,696	185,933
1911	208,923	202,295	411,218	90,915	99,387	190,302
1912	214,416	207,228	421,644	92,959	101,539	194,498

BIRTHS.

The Registrar-General in his annual report for 1912 states that the number of births registered was 12,079, equal to a rate of 28·65 per 1,000 of the mean population. The actual number of births was the highest ever recorded in the State, and the rate was 11 per cent. above the average for the last 10 years. The natural addition to population from the excess of births over deaths was 7,743, against 7,019 in 1911. Of the total births registered in 1912, 6,168 were male births and 5,911 female, the proportion of the former to 100 of the latter being 104·35. In England, according to recent returns, the proportion for the five years ended with 1910 was 103·90. The South Australian ratio for the same period was 104·90, and that of the Commonwealth 105·48.

DEATHS.

The deaths registered in 1912 numbered 4,336, being more by 298 than those of the previous year, and the highest number recorded in any year since 1899, being above the decennial average by 440. The death rate per 1,000 of the mean population was 10·28, which was more than the rate for the previous year by 0·46; and as a reference to the comparative statement near the end of this report will show, South Australia had the second lowest rate of all the countries specified. The average death rate for the last five years was 10·01. The average rates for the same period in the other Australian States were as follows:—Queensland, 10·26; New South Wales, 10·24; Tasmania, 10·60; Western Australia, 10·56; Victoria, 11·87.

Arranged in their respective divisions and numbers, the causes of death in 1912 and the previous year were as follows:—

			1911.	1912.
I.	{ (A) Epidemic General Diseases	.. ..	162 ..	161
	(B) Other General Diseases	.. ..	815 ..	904
II. to IX.	Local Diseases	.. ..	1,960 ..	2,007
X.	Malformations	.. ..	42 ..	47
XI.	Infancy, Diseases Peculiar to	.. ..	230 ..	319
XII.	Old Age	.. ..	400 ..	480
XIII.	External Causes (Violence, &c.)	.. ..	263 ..	286
XIV.	Ill-defined Diseases or Causes	.. ..	166 ..	132

INFANTILE MORTALITY.

The deaths of infants under 1 year of age numbered 744 (429 males and 315 females), against 669 in 1911, and were in the proportion of 6·16 to 100 births registered. From 1885 to 1912 the proportions were as follows:—

1885	..	..	11·34	1899	..	..	11·16
1886	..	..	12·61	1900	..	..	9·96
1887	..	..	11·12	1901	..	..	10·01
1888	..	..	9·59	1902	..	..	9·38
1889	..	..	9·42	1903	..	..	9·68
1890	..	..	9·65	1904	..	..	7·00
1891	..	..	9·09	1905	..	..	7·28
1892	..	..	9·69	1906	..	..	7·58
1893	..	..	11·65	1907	..	..	6·56
1894	..	..	9·39	1908	..	..	6·99
1895	..	..	9·49	1909	..	..	6·12
1896	..	..	10·14	1910	..	..	7·01
1897	..	..	10·91	1911	..	..	6·05
1898	..	..	13·99	1912	..	..	6·16

The rate for 1912 is somewhat higher than that for 1911, which is the lowest recorded. That a notable reduction has taken place in recent years is manifest, if the two decennial periods ending with 1902 and 1912 be compared; the average rate for the first 10 years is 10·61, and for the second 7·04, a decrease of 34 per cent.

The following tables show the infantile mortality in Australasia and in various other countries, and it will be seen that as far as can be ascertained from published figures South Australia has the lowest rate in the world:—

INFANTILE MORTALITY IN AUSTRALASIA.

Deaths under 1 Year per 100 Births.

Year.	South Australia.	New Zealand.	Queensland.	New South Wales.	Victoria.	Tasmania.	Western Australia.
1907.....	6·56	8·89	7·72	8·86	7·26	8·28	9·77
1908.....	6·99	6·79	7·03	7·60	8·61	7·52	8·47
1909.....	6·12	6·16	7·19	7·43	7·13	6·49	7·80
1910.....	7·01	7·06	6·31	7·46	7·69	10·17	7·80
1911.....	6·05	5·63	6·55	6·95	6·87	7·37	7·62
1912.....	6·16	5·12	7·14	7·13	7·45	6·66	8·21
Average 1907-1912.,	6·48	6·61	6·99	7·57	7·50	7·75	8·28

INFANTILE MORTALITY IN VARIOUS COUNTRIES.

Russia (European) ..	25·6	England and Wales ..	12·1
Austria ..	21·5	United Kingdom ..	12·6
Roumania ..	21·3	The Netherlands ..	12·6
Hungary ..	20·7	Scotland	11·3
German Empire ..	19·3	Denmark	11·3
Prussia	18·0	Ireland	9·5
Spain	17·0	Western Australia ..	8·3
Italy	16·3	Sweden	8·5
Japan	15·3	Tasmania	7·8
Serbia	15·0	Victoria	7·5
Bulgaria	15·0	New South Wales ..	7·6
Belgium	14·8	Norway	7·4
Ontario, Province of ..	14·2	Queensland	7·0
France	13·9	New Zealand	6·6
Switzerland	13·0	South Australia	6·5

The rates in this table for countries outside Australasia are for the average of the latest five years available.

MARRIAGES.

The proportion of married persons in South Australia at the time of the census of 1911 was slightly more than one-third of the whole population, as the following statement will show :—

Conjugal Condition.	Number.			Proportion per Cent.		
	Males.	Females.	Total.	Males.	Females.	Total.
Never married	132,342	119,330	251,672	63.82	59.31	61.66
Married ..	69,102	69,385	138,487	33.32	34.48	33.90
Widowed ..	5,627	12,334	17,961	2.71	6.13	4.40
Divorced ..	93	62	155	.05	.03	.04
Not stated ..	194	89	283	—	—	—
Total ..	207,358	201,200	408,558	100.00	100.00	100.00

The marriages registered in 1912 numbered 4,056, not only being more by 20 than those celebrated in 1911, but also being the highest number ever recorded in any one year. Since 1903 every year has shown a satisfactory advance in marriages, and the number in 1912 is 79 per cent. higher than that for 1903. The marriage rate (that is, the rate of marriages not of persons married) per 1,000 of the mean population was 9.62 against 9.81 in the previous year, and was the second highest rate ever recorded. The South Australian marriage rate for 1912 was the highest in Australasia. New South Wales being next highest with 9.54. The marriages celebrated in the first quarter of the year numbered 920 ; in the second, 1,090 ; in the third, 936 ; and in the fourth, 1,110.

The number of marriages celebrated according to the ceremonies of each religious denomination and the number of civil marriages are shown in the following statement :—Methodist, 1,318 ; Church of England, 103 ; Roman Catholic, 400 ; Baptist, 300 ; Lutheran, 221 ; Congregationalist, 264 ; Presbyterian, 213 ; Church of Christ, 182 ; Registrar-General, Deputy Registrar and District Registrars, 152 ; Salvation Army, 42 ; Christian Brethren, 23 ; Officiating Registrars, 21 ; Seventh Day Adventists, 7 ; Unitarian, 6 ; Latter Day Saints, 2 ; Jewish, 2.

It is a well-known fact that the marriage rate very quickly responds to changes in economic conditions, and the rise or fall in marriage rates, or in the value of exports or imports, is generally regarded as being in some degree

indicative of a corresponding change in the prosperity of a country. The following table shows the variations year after year from 1900 to 1912 in such rates and values in South Australia :—

Year.	Marriage Rate per 1,000 of Mean Population.	VALUE PER HEAD OF MEAN POPULATION.		
		Imports Re- tained for Home Consumption.	Exports of South Australian Produce.	Imports and Exports United.
			£ s. d.	£ s. d.
1900 ..	6.51	10 4 2	10 3 9	20 7 11
1901 ..	6.44	9 14 3	11 15 10	21 10 1
1902 ..	6.60	8 14 8	13 5 0	21 19 8
1903 ..	6.36	9 12 2	14 5 2	23 17 4
1904 ..	7.08	12 8 8	15 13 6	28 2 2
1905 ..	7.21	13 8 8	16 5 4	29 14 0
1906 ..	7.38	13 16 10	19 15 4	33 12 2
1907 ..	8.35	18 5 7	22 18 2	41 3 9
1908 ..	8.23	15 4 5	21 13 6	36 17 11
1909 ..	8.43	18 9 11	21 14 3	40 4 2
1910*..	9.21	14 11 6	25 15 2	40 6 8
1911*..	9.81	15 3 9	24 14 10	39 18 7
1912*..	9.62	16 10 9	22 16 1	39 6 10

* Owing to the cessation of records of interstate trade only the value of oversea imports and exports can be given for these years.

MEAN AGE AT MARRIAGE.

Year.	Mean Age of Bridegrooms.	Mean Age of Brides.
1908	28.86	25.44
1909	28.46	25.50
1910	28.95	25.51
1911	28.69	25.34
1912	28.52	25.49

The following were the average ages in England, some Australian States, and New Zealand :—

	Year.	Men.	Women.
England	1910 ..	28.92 ..	26.75 ..
Victoria	1911 ..	30.09 ..	26.24 ..
New Zealand	1911 ..	30.12 ..	26.48 ..
New South Wales	1911 ..	28.81 ..	25.32 ..
Queensland	1911 ..	28.82 ..	24.71 ..

Amongst the persons married during the year, seventeen (nine men and eight women) described themselves as divorced.

The following figures show the proportion of births to each marriage in South Australia for 25 years, in each instance the births compared being for the year given and the marriages for the year before :—

1888	..	..	..	5·17	1902	..	..	..	3·71
1889	..	..	..	4·83	1903	..	..	..	3·12
1890	..	..	..	4·90	1904	..	..	..	3·87
1891	..	..	..	4·66	1905	..	..	..	3·34
1892	..	..	..	4·42	1906	..	..	..	3·30
1893	..	..	..	4·90	1907	..	..	..	3·30
1894	..	..	..	4·81	1908	..	..	..	3·01
1895	..	..	..	4·87	1909	..	..	..	3·10
1896	..	..	..	4·72	1910	..	..	..	3·08
1897	..	..	..	4·72	1911	..	..	..	2·89
1898	..	..	..	4·42	1912	..	..	..	2·85
1899	..	..	..	4·08			Mean	..	4·00
1900	..	..	..	3·87				—	—
1901	..	..	..	3·78				—	—

It would seem from these figures that 4·00 is the average number of children born in South Australia to each marriage. It will be seen, however, that during the last ten years the proportion has, on the whole, been showing a decidedly downward tendency, though there was a slight improvement in 1904.

The proportions in the other Australian States and New Zealand were as follows :—

Tasmania ..	..	1911 ..	3·45	|	New South Wales ..	1911 ..	3·12
Western Australia ..	1911 ..	3·67		|	New Zealand ..	1911 ..	3·07
Queensland ..	..	1911 ..	3·34	|	Victoria ..	..	1911 .. 3·13

Viewed as a whole, 1912 showed a great improvement with respect to births and natural increase of population. In regard to marriages, it was the best year the State has known, while in reference to its mortality, though not a bad year, it was not as favorable as any of the five preceding years. In the comparative statement with other countries South Australia shows the twelfth highest birth rate, the second highest marriage rate, the second lowest death rate, and the fourth highest natural increase. If, however, only the Commonwealth (the Australian States), and New Zealand are considered, South Australia shows the fifth highest birth rate, the highest marriage rate, the second lowest death rate, and the fourth highest natural increase.

IMMIGRATION.

AJUDICIOUS system of immigration has been inaugurated for the purpose of adding to the population of the State. The underlying principle is that there shall be no indiscriminate immigration. The regulations under which immigrants are to be introduced may be divided into two sections, one for nominated persons and the other for selected immigrants. The nomination system is of great value to newly arriving settlers who are thereby able, when satisfied with their new home, to induce relatives and friends to follow them to the State.

Any natural-born or naturalised subject of His Majesty resident in the State may nominate any person for an assisted passage in the form of schedule to be obtained at the Crown Lands and Immigration Office. Nominations are accepted only in respect of persons who come under one or more of the following three classes, and who are under 45 years of age if males, married women, or widows, and under 35 years of age if single women, namely :—

- (a) Persons who are closely related to the nominator :
- (b) Persons who are agricultural or other rural workers and their families :
- (c) Persons whose introduction to the State will not, in the opinion of the Minister, cause congestion in the State in any occupation or trade.

If the nominee is residing in a portion of the British Empire other than the United Kingdom or in the United States of America, the full amount of fare charged by the shipping company or owner must be paid, and the amount of the Government contribution will be paid to the nominator if the nominee on arrival in the State is found to comply with the regulations and satisfies the Minister that it is his intention to reside permanently in the State.

Provision is made for assisted passages being arranged by the Emigration Agent in London, without nomination, for persons of the following classes, who are selected by the Emigration Agent or other person appointed by the Minister for the purpose, viz. :—

- (a) Agricultural or other rural workers, with their families :
- (b) Domestic helpers :
- (c) Boys, over 15 years and under 19 years of age, to be apprenticed to farmers :
- (d) Persons whose introduction to the State will not, in the opinion of the Minister, cause congestion in the State in any occupation or trade.

The assisted passage rates payable by persons selected, and in the case of nomination by either the nominator or the nominee, are as follows :—

	£ s. d.
(a) Under 12 years of age	2 0 0
(b) Not under 12 but under 15 years of age—Males	7 0 0
(c) Not under 12 but under 15 years of age—Females	4 0 0
(d) Domestic helpers (selected)	3 0 0
(e) Boys for farm work	10 0 0

The payment of the amounts mentioned will entitle the nominees to accommodation in the open berths only, but passages in four-berth or two-berth cabins may be secured on payment of additional amounts of £2 or £3 respectively for adults and £1 or £1 10s. for children.

Provision is made for assisted passages either upon nomination or otherwise being granted to persons residing in any European country other than the United Kingdom, but in such cases the emigrant must pay his own expenses to London and be approved by the Emigration Agent there.

The age limits for selected immigrants are the same as for nominated persons.

An assisted passage is not granted to any person unless he is sober, industrious, of good moral character, in good health, and free from all mental and bodily defects, and is within the ages specified, appears physically to be capable of labor, and has been vaccinated or has had the smallpox ; nor unless he states that it is his intention to reside permanently in the State ; nor shall a passage be granted to any person in regular receipt of Poor Law relief.

The regulation providing for the selection of any person whose introduction to the State will not cause any congestion in the market is acted upon according to the demand, as to which the Commissioner of Crown Lands and Immigration requires satisfactory information. The Government are particularly anxious to assist immigrants who desire to engage in rural industries, as they are the class required to develop the resources of the State, in preference to those who will increase the city population. Care is taken to limit the supply of agricultural laborers to the demand, and farmers are asked to assist the department in doing so by advising their requirements ; but they are not required to sign any guarantee of employment or pay any amount other than the cost of transport of the immigrants from Adelaide to the farms. In the form of application to be signed by the farmers they are asked to state, in addition to other information as regards wages, accommodation, &c., if they can offer permanent employment to suitable men, as the Commissioner expects them to do their part towards settling immigrants by offering them, so far as possible, permanent homes for themselves and families.

Domestic Helpers.—Arrangements have also been made for sending out female domestic helpers under 35 years of age, who, in accordance with the schedule of assisted rates, are required to pay £3 towards their passage-money. Girls who are unable to pay that amount before leaving England are granted passages on signing an undertaking to pay the £3 in monthly instalments over a period of three months after their arrival in South Australia. Instructions have been given for the girls to be drawn, as far as possible, from the rural districts, and the Emigration Agent is being assisted in the selection by a lady superintendent from South Australia. There is a large demand for domestic helpers in the State. The wages offered range from 10s. to 20s. per week.

Boys for Farm Work.—Under legislation passed by Parliament in 1913 assisted passages are offered to respectable boys between the ages of 15 years and 19 years who are physically capable of, and wish to take up, farm work. The Commissioner of Crown Lands and Immigration is empowered to apprentice the boys taking advantage of the scheme to farmers for not less than one and not more than three years, and during the period of apprenticeship the Commissioner will act as guardian to the boys. Ample provision has been made to safeguard their interests as well as to conserve the rights of the employers.

An important point in the scheme is that it provides for compulsory saving of wages. The boy is to be paid out of his wages only 2s. 6d. per week as pocket money, and the balance earned by him will be paid by the farmer to the Government, and placed to the boy's credit in the Treasury, being retained there at 4 per cent. interest per annum until the boy attains the age of 21 years, when the amount to his credit will be paid to him. After debiting the boy's account with travelling expenses to the State, and the cost of clothing and other necessaries purchased for him, he should have from £70 to £100 to his credit on attaining the age of 21 years, and by transferring the amount to a Savings Bank account, and adding to it from wages subsequently earned, he would soon be in a position to become a farmer on his own account. The minimum rate of wages to be paid to the boys will be subject to the approval of the Commissioner of Crown Lands and Immigration.

The amount that must be paid by each boy is £10. This will, in addition to the cost of passage, cover expenses incurred by the State on the boy's behalf before leaving England, during the voyage, and after his arrival in the State, until he reaches his destination. Arrangements will be made for the amount to be advanced if necessary, and refunded by the boy out of wages earned after his arrival.

MIGRATION.

The following return shows the net results of immigration and emigration for each of the last 10 years, and the total for that period.

It will be observed that, whilst the State lost 10,597 by emigration from 1903 to 1906, there was a gain of 24,612 from 1907 to 1912, resulting in a net gain of 14,015 for the 10 years.

Year.	Increase (+) or Decrease (-) by Migration.		
	Males.	Females.	Total.
1903	-3,282	-1,294	-4,576
1904	-693	-2,353	-3,046
1905	+470	-2,288	-1,818
1906	+784	-1,941	-1,157
1907	+543	+1,134	+1,677
1908	+3,985	+2,261	+6,246
1909	+672	+112	+784
1910	+4,606	+2,839	+7,445
1911	+2,657	+1,628	+4,285
1912	+2,204	+1,971	+4,175
Totals	+11,946	+2,069	+14,015

ASSISTED IMMIGRANTS, 1911 TO 1913.

Classification.	1911.			1912.			1913.		
	M.	F.	Total.	M.	F.	Total.	M.	F.	Total.
Miscellaneous Workers..	145	—	145	787	—	787	535	2	537
Domestics	—	31	31	—	247	247	—	381	381
Dependants	170	319	489	677	1,501	2,178	575	1,266	1,841
Total	315	350	665	1,464	1,748	3,212	1,110	1,649	2,759

OCCUPATIONS OF THE PEOPLE.

AT the time of the last census (April, 1911), the Federal Statistician collected information dealing with the "occupations of the people." There are eight classes under which the people are tabulated, namely :—
 1. The professional, which includes those engaged in Government, defence, law, ministering to religion, charity, health, education, &c. 2. Domestic, engaged in supplying board and lodging, domestic service. 3. Commercial, which covers dealers in all manner of articles. 4. Transport and communication, which covers those engaged in traffic on railways, roads, seas, and rivers, postal, telegraph and telephone services, messengers, &c. 5. Industrial, including workers under all headings. 6. Primary producers. 7. Independent. 8. Dependents on natural guardians or supported by voluntary or State contributions, or under legal detention. 9. Unspecified. . . .

The figures for South Australia show the following totals :—

Class.		Male.		Female.
1. Professional—				
Government, &c. . .	2,169	..		84
Religion, &c. . .	4,475	..		4,445
Totals . . .	6,644	..		4,529
2. Domestic—				
Board and lodging . . .	1,875	..		2,908
Domestic service . . .	1,543	..		11,152
Totals . . .	3,418	..		14,060
3. Commercial—				
Property and finance . . .	3,484	..		597
Art and mechanics . . .	1,475	..		384
Textile fabrics . . .	2,039	..		1,495
Food and drinks . . .	6,334	..		747
Animals, &c. . .	1,934	..		68
Fuel and light . . .	585	..		7
Metals and minerals . . .	1,377	..		63
Undefined . . .	4,959	..		1,312
Speculators . . .	9	..		1
Storage . . .	108	..		—
Totals . . .	22,304	..		4,674

Class.			Male.		Female.
4. Transport, &c.—					
Railway	..	..	5,052	..	13
Roads	..	..	3,765	..	21
Seas and rivers	..	..	5,339	..	36
Postal, &c.	..	..	1,316	..	277
Messengers	..	..	51	..	—
Totals	..	..	15,523	..	347
5. Industrial—					
Art and medicine	..	..	10,220	..	609
Textile fabrics	..	..	2,456	..	7,087
Food, drinks, &c.	..	..	3,710	..	307
Animals, &c.	..	..	987	..	6
Metals and minerals	..	..	7,362	..	30
Fuel and light	..	..	846	..	13
Construction	..	..	11,837	..	12
Disposal of dead, &c.	..	..	498	..	2
Undefined	..	..	6,469	..	115
Totals	..	..	44,385	..	8,181
6. Primary Producers—					
Agricultural	..	..	36,590	..	1,005
Pastoral	..	..	5,898	..	389
Capture of animals	..	..	328	..	1
Fisheries	..	..	434	..	—
Forestry	..	..	355	..	—
Water conservation	..	..	781	..	2
Mining and quarrying	..	..	3,256	..	9
Totals	..	..	47,642	..	1,406
7. Independent	..	..	931	..	761
8. Dependents—					
On natural guardians	..	..	61,388	..	165,616
Supported by State, &c.	..	..	858	..	751
Criminal class	..	..	29	..	35
Totals	..	..	62,275	..	166,432
9. Unspecified	..	..	4,236	..	810
Grand total	..	..	207,358	..	201,200

WORK AND WAGES.

A LABOR Exchange, with the name of "The South Australian Government Labor Exchange," was established on July 1st, 1911, under the administration of the Commissioner of Public Works, and under the charge of a Superintendent. The Labor Exchange has been specially reorganised to assist private employers of labor throughout the State in obtaining the workmen they require, and to inform the unemployed workmen of the inquiries for workmen of the respective classes. There is kept at the Exchange a register of the names and addresses of public departments and of private employers wanting workmen, with details of their requirements, and also a register of all persons who make application for employment. The operation of the Exchange does not extend to the professional and clerical branches of the Public Service, but applies only to all daily-paid labor employed in the Public Service. Daily-paid men are not employed by the officers of any department of the Service excepting by requisition through this Labor Exchange. The head office of the Labor Exchange is situated in Adelaide, but branch offices are to be established throughout the State at such places as the Commissioner may think necessary.

OBLIGATIONS OF EMPLOYERS.

Heads of departments in the Public Service, including the Railway Department, when requiring the services of daily-paid men (adult or youth labor) apply by requisition to the Superintendent of the Labor Exchange for such men or youths. As the Superintendent of the Labor Exchange is required to pay in advance the fares by rail, land, or steamer of the workmen sent by the Exchange to works in the country, the department concerned is debited with the full costs of such fares, and if the men are not employed for the full term of two calendar months the department is also debited with the return fares of such men; if the men are employed over two months no return fare is allowed. The amount paid by the Labor Exchange for fares to the work is deducted from the men's wages. If the work does not last for over two months the men are entitled to a refund of the amount deducted from their wages for fares, and such refund is paid by the Labor Exchange to the men on the production by them of a refund certificate signed by the departmental officer under whom they were working; and the amount so refunded is charged to the department concerned. If the work lasts over four months the men are not entitled to any consideration for fares either way.

The Government Labor Exchange is made available to private employers, who are invited to send details of their requirements to the Superintendent. If so desired, employers can select the labor required, or the Exchange makes the selection.

CURRENT RATE OF WAGES.

The following statement, prepared at the Government Labor Exchange, shows the rates of wages current in South Australia :—

Trade or Calling.	Rate per Day.	Trade or Calling.	Rate per Day.
*Apprentices ..	1s. 4d. to 7s. 6d.	Plate-levellers ..	12s. 6d.
Brieklayers ..	12s.	*Pattermakers ..	11s. 6d.
†*Boilermakers ..	12s.	*Painters, Coach ..	10s.
" Assistants	8s. 6d. to 9s.	" " House ..	9s. 8d. to 10s.
*Blaeksmiths ..	10s. 6d. to 11s. 6d.	*Paperhanglers ..	9s. 6d. to 10s. 6d.
Boltmakers ..	9s. 6d. to 10s.	*Plumbers ..	11s. 4d.
*Brassfinishers ..	10s.	*Plasterers ..	12s.
*Coremakers ..	10s.	Springsmiths ..	11s. 6d.
Coppersmiths ..	11s.	*Strikers ..	8s. 6d. to 9s.
*Carriagemakers ..	10s. to 11s.	Stonecutters ..	12s.
*Carpenters ..	11s.	*Sawyers ..	7s. 6d. to 9s. 6d.
Crane Attendants ..	8s. 6d.	Tilelayers ..	12s.
*Fitters ..	11s. 6d.	*Turners ..	11s. 6d.
*Furnacemen ..	8s. 6d. to 9s. 6d.	*Tinsmiths ..	8s. 6d. to 9s. 6d.
*Fettlers ..	8s. 4d.	*Trimmers (Coach) ..	10s.
Forgemen ..	13s.	*Wagonmakers ..	10s. to 10s. 6d.
" Assistants	9s.	Wheeltyrers ..	10s.
*Gasfitters ..	10s. 4d. to 11s.	*Wireworkers ..	7s. 6d. to 8s. 6d.
Ironworkers ..	11s. 6d.	*Watchmen ..	7s. to 9s. 4d.
* " Galvanized ..	10s. 4d.	Farm Laborers ..	20s. to 50s.† per week and keep
†Laborers, Builders'	10s. to 11s.	" Youths ..	10s. to 20s. per week and keep
* " General ..	8s.	Married Couples ..	£70 to £100 per annum and keep
*Leatherworkers ..	9s. to 10s.	Cooks ..	From 20s. per week and keep to 8s. per day without keep
*Machinists ..	8s. 8d. to 11s. 6d.		
Masons (Wallers) ..	12s.		
Miners ..	8s.		
*Moulders ..	9s. to 11s.		

In the trades marked thus * the lower rate shown is the minimum fixed by the Wages Board. † Fixed by Industrial Court.

The following particulars respecting rates of wages fixed by Wages Boards under the Factories Acts in the trades mentioned have been supplied by the Chief Inspector of Factories :—

Per Week.

Agricultural Machinery and Implement Making	45s. to 66s.
Baking and Pastry-cooking	60s.
Bootmaking and Repairing	54s.
Brassworking, Bedstead-making, Wireworking, etc.	43s. to 61s.
Brickmaking	34s. to 66s.

Rates of Wages Fixed by Wages Boards—continued.

	Per Week.
Brushmaking	52s. 6d. to 67s. 6d.
Butchering	45s. to 60s.
Carrying and Driving	48s. to 55s. 6d.
Confectionery (manufacturing)	45s. to 54s.
Coopers	42s. to 66s.
Dressmaking	16s.
Electrical Working	48s. to 72s.
Fruit Preserving	45s. to 48s.
Furniture Manufacturing	48s. to 56s.
Hairdressing	55s.
Jewellers and Opticians	60s.
Millinery	16s. 6d.
Printing Trades	45s. to 80s.
Saddlery and Harness-making	54s. to 60s.
Shop Assistants—Hardware	37s. 6d. to 90s.
“ Retail Drapery, &c.	42s. 6d. to 57s. 6d.
“ Retail Grocery	55s. to 90s.
Warehouse Assistants—Wholesale Grocery	46s. to 77s. 6d.
Storemen, Packing, Portering, &c.	42s. to 56s.
Tailoring	42s. to 70s.
Tanning and Currying	45s. to 52s.
Timber Trades	45s. to 69s.

DOMESTIC HELPERS.

Inquiries recently instituted by the Government have proved that a shortage of domestic helpers exists in South Australia, and the following rates, with good accommodation and reasonable hours, are being paid generally:—

	Per Week.
Cooks (Hotels and Restaurants)	25s. to 30s. with board and lodging.
“ (Private houses)	18s. to 20s. “ “
House and Parlor Maids (Hotels, &c.)	15s. to 20s. “ “
“ (Private)	10s. to 20s. “ “
General Servants	10s. to 16s. “ “
Nursemmaids (about 15 years)	6s. to 10s. “ “
Laundresses	Up to 21s. “ “
Waitresses (Country Hotels)	Up to 20s. “ “
“ (City Restaurants)	15s. to 20s. without lodgings.

CROWN LAND LAWS AND SETTLEMENT.

CONDITIONS OF ALLOTMENT.

PURCHASE-MONEY AND RENT.

CROWN lands in South Australia are subdivided into such sized blocks as may be recommended by the Land Board and approved by the Commissioner of Crown Lands. The land is then gazetted open to application at purchase-money and rent fixed by the Board and approved by the Commissioner; the rent under the present law is, as a rule, fixed at 4 per cent. on the purchase value of the land.

Under Act 1109 of 1912 the holder of land under agreement with covenant to purchase is not required to pay any interest for the first four years of the term of the agreement, which will be for 36 years. During the fifth and sixth years interest at 2 per cent. per annum on the purchase-money fixed will be payable, and from the commencement of the seventh year the purchase-money and interest (at 4 per cent. per annum) will be payable by 60 half-yearly instalments at the rate of £2 16s. 5d. for every £100 of the purchase-money. The holder of land under agreement has the right to complete purchase at any time after the expiration of six years of the term, provided he has complied with all the covenants of the agreement, and has expended a sum equal to 5s. per acre in effecting improvements on the block to the satisfaction of the Commissioner.

Under the same Act the rent under perpetual lease is fixed at 4 per cent. per annum on the value placed on the land by the Board. The lessee, however, is not called upon to pay any rent for the first four years of the lease. During the fifth and sixth years he will pay 2 per cent. interest on the purchase value of the block, and from the beginning of the seventh year the full annual rent, at the rate of 4 per cent. on the purchase value, will be payable.

The Act of 1912 will apply to newly-opened lands and such other lands as the Commissioner may direct, the object being to give assistance to settlers undergoing pioneering difficulties.

The holders of both agreements to purchase and leases will be required to clear and render available for cultivation not less than one-eighth of the cultivable area, as specified in the *Gazette* notice, during the first two years of the term of the agreement or lease, and also a similar area during the second two years of the term, and thereafter during each succeeding year

they must clear and render available for cultivation not less than one-eighth of the specified cultivable area until three-fourths of such area has been cleared and rendered available for cultivation. The area so cleared must be maintained in a cultivable condition during the currency of the agreement or lease.

The settlers are also required to reserve five acres out of every 250 acres comprised in their blocks for the growth of timber, and must not destroy any timber trees on the area so reserved.



Clearing Scrub, Prior to Cultivation.

SIZE OF BLOCKS.

As pointed out, purchase-money and rent are fixed by the Land Board on the value of each block according to its quality ascertained after inspection. No purchase-money or rent can be quoted for any particular district. After survey has been effected of the necessary roads and reserves, the Land Board recommends the size of the blocks into which the land is to be divided. These blocks generally vary from about 1,000 to 1,500 acres, which is quite sufficient for a farm where the land is fairly good for wheat-growing.

APPLICATIONS—HOW MADE.

After the land has been surveyed it is gazetted open to application for periods ranging from one to two months. All applications must be lodged with the Surveyor-General by a specified date, which is notified in the

Government Gazette, and subsequently places and times are fixed at which the Land Board will hold meetings to take evidence from persons desirous of making oral statements in support of their applications. The evidence is given on oath in open court, and persons present have the right, and are invited to challenge any statement made which they believe is incorrect. After the Board (which consists of three members) has heard all applicants, or as many as have attended to give evidence personally in support of their applications, it proceeds to make the allotment, each application being dealt with on its merits. All other things being equal, the Board is required by Act to allot the land to the applicant who agrees to reside on it for at least nine months in each year ; and if it is not so allotted, a reason must be assigned for departing from the directions of the Act. The Board's decision on allotment is final.

PROVISION FOR WATER AND ROADS.

During the past year considerable alteration has been made in the method of dealing with Crown lands suitable for agriculture. In the country north and south of the Tailem Bend and Brown's Well railway line, east of the River Murray, wells and bores have been put down in the hundreds offered for application, and roads have been and are still being cleared for the use of settlers. The cost of these works is added to the price of the land and, considering the great benefit which will be derived by the new settlers, the small additional amount per acre which they will be called upon to pay will be scarcely felt by them. The same provision will be made on the lands in course of survey and to be surveyed for settlement in all hundreds in this district.

On the land in course of survey for offer on Eyre's Peninsula, water will be provided for the use of new settlers by means of tanks and reservoirs, and roads will be cleared and the cost charged to the blocks in a similar manner to that previously described.

Settlers may apply to have rain sheds and tanks erected on their holdings by the Commissioner for the purpose of conserving water, and may obtain a loan from the Advances to Settlers Board to pay for such work ; or, under another Act, they may apply to the Commissioner to have such sheds and tanks erected on giving an undertaking to pay the cost of the work as certified by the Commissioner, with interest as may be fixed from time to time by proclamation, the payments to be made concurrently with the rent or half-yearly instalments. The latter provision relieves the settler of the necessity of mortgaging his holding, as would be obligatory if he obtained a loan. This legislation should be of great benefit to many settlers in districts where water is not obtainable except at considerable cost, as it will enable them to get on to the land with a sufficient supply of water for them to proceed with the

work of development until they can construct tanks or reservoirs, as the nature of the country may permit. These sheds will not only afford catchment for water, but can be utilised as temporary dwelling places, and a protection for machinery, &c.

TRANSFERS OF LEASES AND AGREEMENTS.

No transfer of any lease or agreement can take effect unless first approved by the Commissioner of Crown Lands on the recommendation of the Land Board, and no land that has not been held for five years can be transferred unless the holder thereof proves that refusal to allow the transfer would inflict great hardship on him. This restriction does not, however, apply to transfers by executors or administrators to devisees. All applications to transfer—except those last mentioned above—must be gazetted for not less than two weeks; this also applies to applications for permission to sublet where the land has not been held for six years and the term of the proposed under-lease exceeds three years.

Should the holder apply to transfer any agreement or lease of land allotted under the provisions of Act 1109 of 1912 before the expiration of the sixth year of the term, the Commissioner may require that instalments or rent shall be payable as from the time when the transfer takes effect, *i.e.*, the transferee will not necessarily receive the concession as regards rent or interest during the first six years of the lease or agreement, as the case may be.

CLOSER SETTLEMENT LANDS.

Lands repurchased by the Government for the purposes of closer settlement are allotted in the same manner as ordinary Crown lands.

The first measure authorising the repurchase of land for closer settlement was passed in 1897. This Act provided that the land repurchased was to be offered on perpetual lease only, at a rental of not less than 4 per cent. per annum on the cost of the land, including expenses of subdivision, &c.

In 1902 an Act was passed abolishing the system of leasing repurchased land in perpetuity, and providing for such land being offered on agreement with covenant to purchase. Under this Act the term of the agreement was for 30 years, the purchase-money, with interest thereon, being payable in 60 equal half-yearly instalments at the rate of £2 16s. 5d. for every £100 of purchase-money. The Crown Lands Act of 1903 contained the same provisions. The purchaser had the right of completing purchase at the expiration of six years if he had fulfilled all the conditions of the agreement.

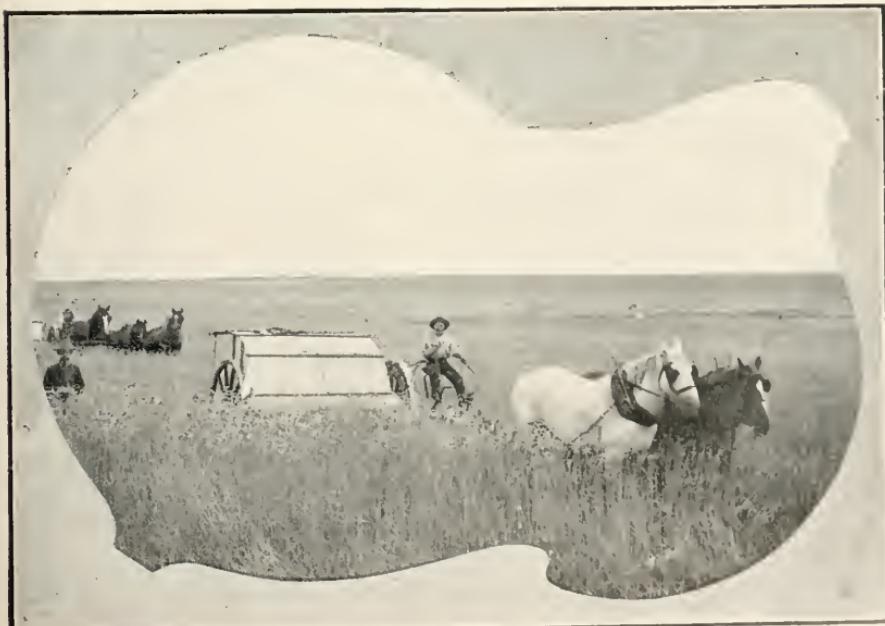
In 1905 a further Act was passed which extended the term of the agreements to 35 years, during the first five of which the purchasers are required to pay interest only at the rate of 4 per cent. per annum on the purchase-money

fixed for the blocks, after which purchase-money and interest become payable as under the Acts of 1902 and 1903. The purchasers cannot, however, complete purchase until the land has been held for nine years.

The conditions of closer settlement agreements require the purchasers to expend during the first five years of the term a sum equal to £3 for each £100 purchase-money in substantial improvements, such as buildings, fences, or making provision for water, &c. The purchasers are also required to fence the boundaries of the blocks within five years from allotment of the land. If there are improvements on the land at the time of allotment, they are paid for in precisely the same manner as the land, or the purchaser has the option of paying for them in cash, and the amount which he is required to pay for such improvements is set against that which the conditions of the agreement require him to expend in improvements during the first five years of the term.

Under the Crown Lands Amendment Act of 1911, the purchaser can — on any date when his instalments are payable — pay off the purchase-money any sum of not less than £50, or any multiple thereof; this, however, does not entitle him to obtain the grant of the land until the prescribed period has expired.

The holders of these agreements are not entitled to cut any growing timber on the land during the first five years, except for the purpose of effecting improvements or rendering the land available for cultivation, and then only with the written consent of the Commissioner of Crown Lands.



Stripping Wheat.

HOMESTEAD BLOCKS.

Land for working men is offered in blocks, the unimproved value of which must not exceed £100, and the holder, or a member of his family, must reside on the land for at least nine months in each year. The lands are offered on either agreement to purchase or perpetual lease; and the purchase-money and rent are fixed in the same manner as for ordinary Crown lands. The holders of these blocks have one advantage which is not granted to the other Crown tenants; they can protect their holdings from sale by creditors by having their titles indorsed as "Protected Homestead Blocks." This indorsement can also be carried on to the land grant when the holder completes purchase. The effect of this indorsement is that no subsequent mortgage will have any validity, nor can any creditor take action for the sale of the holder's interest in the lease or agreement for the recovery of any debt contracted after the indorsement of the deed. The indorsement cannot be removed except in the case of transfer, when the transferee may request that such indorsement be removed from the title.

MAXIMUM AREA OF HOLDINGS.

Of ordinary Crown lands, suitable for agriculture only, or for agricultural and pastoral purposes combined, one person can hold an area which, together with land already held by him under any tenure—excepting pastoral lease—would not exceed £5,000 unimproved value; or if the land is suitable for grazing purposes only, and is within Goyder's line of rainfall, he can hold up to the carrying capacity of 5,000 sheep or an equivalent number of great cattle, whilst if the land is outside Goyder's line of rainfall the limitation is a carrying capacity of 10,000 sheep or an equivalent in great cattle. This provision applies to land whether acquired by allotment, transfer, or under lease.

Of land repurchased for closer settlement the purchaser can hold up to the unimproved value of £4,000, if suitable for agriculture or for agricultural and grazing purposes combined, or up to the unimproved value of £5,000 if the land is suitable for pastoral purposes only. In cases where there are excessive improvements there is no limitation of the unimproved value of repurchased land which may be held by one person.

ASSISTANCE TO SETTLERS ON CROWN LANDS.

The holders of agreements or leases, which include the lessees of reclaimed and irrigation lands, can apply to the Advances to Settlers Board for loans up to £850, for the purpose of effecting improvements on their holdings, paying off mortgages, purchasing stock, or for any other purpose.

The board has power to advance up to £650 for the purpose of effecting improvements, paying off mortgages, or for any other purpose. It can also

lend up to £200 for the purchase of stock with which to stock the holding; the security in this case must be equal to one-third more than the advance to be made. For effecting improvements the first £400 can be advanced £1 for £1 on the full value of improvements and of lease to that amount, and the balance of £250 up to 75 per cent. of any additional value of such improvements and lease. For the other purposes the money can be advanced up to 75 per cent. of such value.

Examples.—Suppose a lessee holds a lease which with improvements is worth £360; he would be entitled to a loan of £360 for effecting further improvements, or for any other purpose to a loan of £270, *i.e.*, 75 per cent. of such value.

If his lease, with improvements, were worth £600 he could obtain for effecting improvements a loan of £550, arrived at as follows:—

For £400 value, £1 for £1	£400
For £200 additional value at 75 per cent.	150
	£550

The borrower pays interest only for the first five years of the term, after which he commences to pay the principal and interest in half-yearly payments extending over 25 years. The interest is charged at a rate fixed from time to time by proclamation, and if it be paid within 14 days from due date a rebate of 1 per cent. is allowed, *i.e.*, if the rate fixed is $5\frac{1}{2}$ per cent. and the borrower pays within the specified period of 14 days, only $4\frac{1}{2}$ per cent. interest will be required from him.

The Advances to Settlers Act has been largely availed of, especially under the more liberal terms provided in Acts of 1911 and 1912. Up to the 31st December, 1912, £117,717 had been advanced to 481 settlers, over £80,000 of which was paid during the year 1912.

ADVANCES ON HOMESTEAD BLOCKS.

Loans not exceeding £50 can be granted to the holder of a homestead block on half the value of existing improvements for the purpose of effecting additional improvements on the land, and are repayable with interest at the rate of 4 per cent. per annum in 20 equal annual instalments at the rate of £7 7s. 2d. per centum. The borrower has the right to pay off the loan at any time.

ADVANCES FOR WIRE NETTING AND VERMIN-PROOF FENCING.

Loans are granted to agriculturists, pastoralists, and others for the purchase of wire netting for the purpose of protecting crops from the ravages of rabbits, and for erecting dog-proof fences to prevent the inroads of wild dogs, which

have proved very destructive to the flocks of settlers. These loans are repayable by 20 annual instalments with interest at a rate fixed from time to time by proclamation. Since 1890 nearly £600,000 has been advanced for the purchase of wire netting and for the purpose of erecting vermin-proof fencing. The system has proved highly satisfactory, and, but for the assistance given the settlers in this direction, a large area of land, which is now successfully occupied for agricultural and pastoral purposes, would have remained practically unoccupied, while the yield of wheat would not have been nearly so great as at present had the farmers not protected their crops with wire netting.

TOWN LANDS.

Town lands are surveyed in lots usually one-quarter of an acre in area, and each town is, where practicable, surrounded by park lands. The town lands are offered at auction at upset prices ranging from £10 per acre upwards, the purchaser being required to pay 20 per cent. of the purchase-money at the time of sale, and the balance within one month. Hitherto there has been no limitation to the number of allotments which could be purchased by one person ; but under the provisions of Act 1109 of 1912 the Commissioner of Crown Lands may direct that not more than a specified number of allotments shall be purchased by or on behalf of any one person, and should more than such number of allotments be acquired contrary to the provisions of the Act the sale will be cancelled and become void, notwithstanding the fact that the title may have been issued for the allotments so purchased. Allotments purchased under the provisions of this Act cannot be transferred, mortgaged, or otherwise dealt with within a period of six years from date of the sale without the consent in writing of the Commissioner of Crown Lands ; and if any dealing takes place contrary to this condition the sale will become void and the land revert to the Crown.

LANDS AVAILABLE FOR SETTLEMENT.

There are approximately 3,000,000 acres of land on Eyre's Peninsula, and between the Pinnaroo hundreds and the River Murray, surveyed but not yet offered, in course of survey, and to be surveyed. These lands will be available for application during the next few years, and the greater portion will be served by railways constructed, in course of construction, or authorised, viz., the Tailem Bend and Brown's Well line, Karoonda and Peebinga line (under survey), and the Darke's Peak extension, and Yeelanna and Minnipa Hill lines. The Minnipa Hill and Decres Bay line (under construction) will also be the means of developing a large area of land north-westerly from the present terminus of the Minnipa Hill line.

There are now over 600,000 acres surveyed and ready for offer, and supplies of water are being provided on the land. About 750,000 acres of land on Eyre's Peninsula and south of the River Murray are in course of survey, and the survey of the greater portion of this area should be completed during the present year.

Although this land was formerly considered unsuitable for agricultural purposes, it has now—owing to the use of superphosphates and the more economical and improved system of cultivation in force during the last few years—become valuable agricultural country, and in ordinary seasons will yield a fair average crop of cereals. Of the approximate area of 3,000,000 acres it is estimated that quite half will, during the next few years, be found suitable for cultivation. In addition to this area it is not improbable that in the near future other land hitherto considered useless for farming purposes will, with still further improved means of economical cultivation, be found to be suitable for agricultural settlement. Such settlement would, however, be impossible without further railways to afford a ready means of transport to suitable shipping places.

There is a large area of land south of the Pinnaroo hundreds which has, owing to the density of the scrub and the absence of fodder plants for stock, been considered comparatively useless for grazing, and through the sandy character of the soil has not been thought fit for agricultural purposes. Experience has, however, proved that somewhat similar land in the southern portion of the hundred of Pinnaroo has grown fairly good crops, and during the next 10 years it is anticipated that a large area of this country will be utilised for agriculture and grazing combined. On account of the good rainfall (about 17in. a year) it is believed that fodder grasses would readily grow if planted on the parts too sandy for agriculture, while there are numerous flats and valleys fit for the growth of cereals.

WHERE TO OBTAIN INFORMATION.

The Lands Department affords every facility for intending applicants and other inquirers to obtain information relative to land open to application and to be offered. An officer has been specially appointed for the purpose of answering inquiries in this direction. This officer is conversant with a large portion of the land which is in course of survey and obtains information as to the best means of inspecting the hundreds and other particulars of interest to intending applicants. He also advises them of the conditions under which various lands may be taken up.

This department distributes free of cost about 16,000 plans annually to inquirers for lands open. These free plans are accompanied by details giving the areas of the blocks and the prices at which they are offered, as well as

a short general description of the land and the conditions under which it may be applied for. When any land is gazetted open to application, placards are distributed over the State notifying the fact, and also that plans and full detail may be obtained on application to the Surveyor-General.

STATISTICAL.

The State of South Australia comprises an area of 243,244,800 acres. Of this area 9,714,988 acres have been granted in fee simple at a purchase money of £11,176,383 ; 122,777 acres have been granted in fee simple without payment for various public purposes ; 2,385,441 acres are in course of alienation under agreements with covenant to purchase representing a purchase-money of £2 413,187 ; 2,721,662 acres are held on leases with right of purchase (these leases were issued prior to January 1st, 1904, when the Bill—providing for the granting of agreements to purchase extending over a term of 30 years—became law) ; 21,988 acres are let on homestead leases ; 15,161,187 acres are held on perpetual leases at an annual rental of £77,994 (10,934 acres of this area are reclaimed lands) ; 717,797 acres are held under miscellaneous leases, chiefly for grazing and cultivation ; and 98,119,410 acres are held under pastoral leases, the terms of which vary from 21 to 42 years. In addition to these areas 177,704 acres have been dedicated as reserves, &c., for various public purposes. The balance of the area of the State, which includes 224,000 acres of fresh-water and 7,686,000 acres of salt-water lakes, is unoccupied country, the greater portion of which is waterless and not fit for occupation in its present state. Should artesian or sub-artesian waters be discovered over this area a large portion of it would be taken up for pastoral purposes. The railway from Port Augusta to Kalgoorlie will probably lead to the development of a considerable area of this unoccupied country.

The land now held from the Crown is included in over 20,000 leases and agreements, held by upwards of 14,000 persons.

In all 629,573 acres have been repurchased for closer settlement, at a cost of £1,949,227. Prior to repurchase the permanent population on these lands was very little in excess of 500, whilst at the present time there are over 5,000 persons residing on the country.

BANKING.

CONCURRENTLY with the growth of internal and external commerce and the rapid settlement of new areas has been the expansion of banking business within the State. Financial operations were originally catered for by the South Australian Banking Company, which was established at the commencement of the colony, but to-day the business is divided amongst the Commonwealth Bank—opened on January 20th, 1913—and eight joint stock institutions.

(a) THE STATE BANK.

The State Bank of South Australia was established under the State Advances Act, 633 of 1895, for the following objects:—

For the raising by mortgage bonds of a State Advances Fund to be placed at the disposal of the Bank for State Advances.

For the making of State advances out the State Advances Fund to farmers and other producers, to local authorities, and in aid of other industries, at reasonable rates on convenient terms, and upon proper securities.

Under the amending Act of 1896 the advantages of the bank were extended to all persons possessed of the necessary securities, and not only to farmers and other producers.

The bank commenced operations in March, 1896, by borrowing money upon the security of its mortgage bonds at from $3\frac{1}{2}$ per cent. to 4 per cent., and has lent out money at one uniform rate, viz., $4\frac{1}{2}$ per cent.

The total value of bonds sold up to March 31st, 1913, was £2,278,970, of which £1,197,530 worth had been redeemed, leaving the value of the bonds current £1,081,440.

EXPANSION OF BUSINESS.

From its inception to March 31st, 1913, the bank had made advances to the extent of £2,370,076, of which sum £1,220,056 had been repaid, leaving the total amount of advances current on the above date £1,150,020.

The amount of principal and interest that had accrued under the half-yearly instalments to March 31st, 1913, was as follows:—

	Principal.		Interest.		Total.
	£		£		£
Accrued	376,319	..	424,629	..	800,948
Paid	373,631	..	424,236	..	797,867
Arrears	£2,688	..	£393	..	£3,081

In connection with these arrears, it must be borne in mind that many applicants elected to take loans for short terms—five, eight, and ten years—which made the amount accruing due for principal more than in all cases they were able to meet in full. The total profit earned by the bank, after deducting working expenses, salaries, board fees, and losses sustained on bad securities amounted to £59,355.

On broad acres where only a small portion of the security consists of buildings, borrowers have been allowed the maximum term under the Act, viz., 42 years, the rate being £5 6s. 6d. per cent. On house property, where the buildings are modern, the term as a rule is 20 and 30 years, the rate being £7 12s. 8d. and £6 2s. 2d. per cent. respectively, but on buildings not of modern design, shorter terms, not exceeding 10 years, only have been allowed, upon which the rate (10 years) is £12 10s. 8d. per cent.

HELPING THE HOMEMAKER.

The Board of Trustees of the State Bank of South Australia are also administering The Advances for Homes Act, 1910. The object of this Act is to enable the Government to make advances to persons of limited means to enable them to provide homes for themselves and their families. The amount set apart each year for advances under the Act was originally £100,000, but an Act was passed in 1912 increasing the limit to £400,000. Loans are granted to enable the borrower to—

1. Erect a dwelling-house on land already held by him.
2. Complete or enlarge his dwelling-house.
3. Purchase land and dwelling-house already thereon.
4. Discharge a mortgage existing on his land and dwelling.

The Board can lend up to 80 per cent. of its valuation of land and building, the maximum advance to any one borrower being £500. The repayment of the loan is provided for by either quarterly or monthly instalments including interest at $5\frac{1}{2}$ per cent., the term of loan ranging from seven to 42 years. A rebate of one-eleventh of the interest is allowed for prompt payment of instalments, thus reducing the rate to 5 per cent. per annum. The advances made to June 30th, 1913, amounted to £729,600, of which amount £45,412 had been repaid, leaving the amount of advances current on the above date £684,188.

The advances were made for the following purposes :—

To assist in erecting 1,658 new houses	£522,364	An average of	£315	1	2
“ purchasing 423 dwellings	£124,996	“	£295	9	11
For the discharge of 291 existing mortgages	£82,240	“	£282	12	3
Total <u>2,372</u>	Total <u>£729,600</u>	“	£307	11	10

The amount that had accrued for principal and interest under instalments to June 30th, 1913, was £49,464 15s. 9d., made up as follows :

	Principal.	Interest.	Total.
Amount accrued . . .	£15,699 15 1 ..	£33,765 0 8 ..	£49,464 15 9
Amount paid	£15,643 17 1 ..	£33,718 2 5 ..	£49,361 19 6
	£55 18 0 ..	£46 18 3 ..	£102 16 3

(b) THE SAVINGS BANK.

On an altogether different footing to the ordinary banks of issue and deposit, but occupying a pre-eminent position amongst the people, is The Savings Bank of South Australia.

This bank first opened its doors for business on March 11th, 1848, under an ordinance to establish a Savings Bank in South Australia "for the encouragement of frugality, and that persons possessing small sums of money beyond what they required for the supply of their immediate wants should be afforded an opportunity of depositing the same on good security to accumulate at interest." Twelve well-known and respected business men, who gave their time and experience to the conduct of the institution, were appointed trustees. A small room was offered to the trustees gratis as an office, and accepted, and the bank opened for the receipt of deposits on Saturdays only from 12 to 2 and from 7 to 9 in the evening, while repayments were made to depositors on Wednesdays only from 12 to 2. There being only one paid official (the Accountant) the trustees took turns in assisting him in the receipt of deposits, &c. This method lasted for some years. The amount any one person could deposit in one year was limited to £30, and no person was allowed to deposit more than £200 in the whole. That the bank met a long felt want was evident from the fact that during the first three Saturdays 41 accounts were opened and an amount of £419 12s. was deposited, which was increased by December 31st, 1848, to 214 depositors, with a total of £5,313 9s. 2d. at their credit. The ordinance permitting the trustees to lend money on mortgage was, as soon as funds were available, taken advantage of, and by the end of the year £3,100 was lent at the rate of 10 per cent. per annum. Securities being plentiful in those days the trustees accepted only the best, a policy which has been adhered to ever since. On June 30th, 1913, the amount lent on mortgage was £2,118,222, at from $4\frac{1}{4}$ to $5\frac{1}{2}$ per cent.

Mortgagors, if borrowing only about 50 per cent. of the value of their property, are allowed to repay, after the first year, loans of £1,000 or under on any quarter day without giving any notice for the repayment. Loans are also granted up to two-thirds of the value of a property for the purpose of erecting cottages, villas, or shops with dwellings on a system of quarterly repayments of principal and interest. These loans have been of great help

to persons who have not possessed sufficient funds to enable them to purchase homes and farms for themselves without considerable assistance.

The Act under which the bank is administered is a Public Act, and the Government of the State appoint the trustees. The bank having greatly developed from a somewhat philanthropical commencement into a large business institution, the Government in 1903, by Act of Parliament, altered the constitution of the board from 12 trustees, whose services were honorary, to six paid members, who are required to meet at least one day a week for the transaction of business. They have sole control in the management of the institution and the investment of its funds. The expenses of management, which were 12s. 8 $\frac{3}{4}$ d. per £100 of total funds in 1887, have been reduced to 7s. 8d. per £100 in 1913.

A further amendment of the Bank's Act was made during the 1912 Session of Parliament, the principal effect of which was to secure to the depositors a Government guarantee for the repayment of all deposits made with the bank, and to grant to the trustees power to prescribe the amount on which interest would be payable. Under this power it was decided to pay interest on balances up to £350 instead of £250 as formerly.

Estimating the population of the State on June 30th, 1913, at 433,718, the proportion of depositors to population was 54 in every 100 persons. The average amount at credit of each depositor was £42 1s. 7d.

The general progress of the institution is clearly exemplified by the following decennial return :—

Year.	Number of Depos- itors with Aeeounts Bearing Interest.	Amount Deposited During the Year.	Amount of Depos- itors' Balances.	Rate of Interest Paid.	Reserve Funds at Close of each Year.	Total Funds at Close of each Year.
1857	..	1,775	37,534	64,668	5 $\frac{1}{2}$	5,467
1867	..	8,683	145,207	274,508	6	19,587
1877	..	26,320	548,607	952,414	4 $\frac{1}{2}$	28,448
1887	..	56,085	797,704	1,581,100	5	36,000
1897	..	93,669	1,685,636	3,011,156	3	85,000
1907	..	139,670	2,872,517	5,304,704	3 $\frac{1}{2}$	176,000
1913	...	204,565	5,416,760	8,608,478	{ 3 $\frac{1}{2}$ up to £250 ; 3 $\frac{1}{2}$ over £250 and up to £350 }	265 641
						8,931,948

PENNY BANKS.

One of the most important departures of the bank in recent times has been the establishment of a system of penny savings banks at the various schools

of the State. This was brought into vogue on May 5th, 1908, and was a success from the outset. Agencies had been established in 281 schools to the end of the 1913 financial year, an increase of 49 on the figures for 1911-12, and there were at that date 12,254 depositors, as against 9,983 a year previously. Total transactions during the 12 months to June 30th, 1913, numbered 95,372, and the balance at credit amounted to £10,146, an increase of £2,014. The deposits are collected by the teachers one day in each week and remitted to the bank, repayments being made only at the authorised offices of the bank.

THE BUSINESS SIDE.

On June 30th, 1913, the liabilities of the bank aggregated £8,931,948, of which £8,636,250 represented depositors' balances interest-bearing and non-interest-bearing—under section 36 of the Act of 1875—with accrued interest thereon, and £10,542 balance of profit and loss account. The reserve fund and other liabilities amounted to £285,156.

RECENT PROGRESS.

In recent years the general prosperity of the State has been strongly reflected in the bank's progress, which has been nothing short of phenomenal.

Year to June 30th.	* Depositors.	* In- crease of.	Amount Deposited.	Amount With- drawn.	Deposi- tors' Balances.	Average.			Interest. Per cent.
						£	£	£ s. d.	
1901 ..	111,537	5,415	1,918,709	1,727,807	3,782,575	33	18	3	3
1902 ..	116,436	4,899	1,985,689	1,903,664	3,974,709	34	2	8	3
1903 ..	120,349	3,913	2,159,347	2,076,423	4,172,720	34	13	3	3
1904 ..	123,455	3,106	2,021,106	2,117,897	4,202,638	34	0	10	3½
1905 ..	126,821	3,366	2,110,977	2,070,222	4,380,358	34	10	9	3½
1906 ..	131,649	4,828	2,459,331	2,233,775	4,750,192	36	1	7	3½
1907 ..	139,670	8,021	2,872,517	2,462,704	5,304,704	37	19	7	3½
1908 ..	148,718	9,048	3,204,265	2,872,277	5,803,301	39	0	5	3½
1909 ..	157,854	9,136	3,585,582	3,238,276	6,328,870	40	1	10	3½
1910 ..	167,577	9,723	3,817,254	3,566,430	6,771,150	40	8	1	3½
1911 ..	179,478	11,901	4,478,646	4,060,160	7,411,710	41	5	11	3½
1912 ..	192,847	13,369	5,172,433	4,605,041	8,223,260	42	12	9	3½
1913 ..	204,565	11,718	5,416,760	5,295,345	8,608,478	42	1	7	{ 3½ to £250; 3½ over £250 to £350 }

* Exclusive of accounts carried to the Depositors' Unclaimed Fund.

CLASS OF DEPOSITORS.

A classification of depositors shows that the largest class include those with accounts for less than £20. The total number of accounts bearing interest

at the end of the 1913 financial year was 204,565, and of these 133,607 had less than £20 at credit. Appended are the details, exclusive of the penny bank accounts—

			1913			
			Accounts.			Amt. £.
To £20	..	..	133,607	..		576,217
£20 to £50	..	..	24,989	..		803,800
£50 to £100	..	..	16,806	..		1,180,458
£100 to £150	..	..	9,399	..		1,138,423
£150 to £200	..	..	5,505	..		941,846
£200 to £250	..	..	4,946	..		1,108,754
Exceeding £250	..	..	7,255	..		2,053,665
Exceeding £350	..	..	2,058	..		805,315

Owing to the Commonwealth Government having intimated that the post offices would not be available as agencies after December 31st, 1912, a comprehensive scheme to still further strengthen the bank's position in the country districts has been carried to a successful issue. In all the larger towns branches under the control of officers of the bank have been established, thus giving local residents all the facilities available at the head office. At the smaller townships the agencies have been transferred to the local trading banks, and to carefully-selected qualified persons. The efficiency of the bank's service in the country districts has thus been amply maintained, and the results have been very satisfactory.

The business of the bank includes systems of inter-State and international transfers whereby depositors can have the whole or portion of their accounts transferred to another State or to any of the Post Office Savings Banks of Great Britain. Arrangements have also been made for the payment of £5 on demand to any depositor at any agency in the State, subject to identification, and for telegraphic repayments at branches and agencies. To encourage depositors and others to use the bank, home savings bank boxes are issued on payment of a small fee; also, large firms are supplied with pay envelopes on which are printed selected mottoes emphasizing the benefits of thrift.

The Bank's Head Office is situated in Currie Street, and the building is generally regarded as one of the principal architectural ornaments of the city.

MINERAL WEALTH.

By L. KEITH WARD, B.A., B.E., *Government Geologist.*

ECONOMIC GEOLOGY.

IT is not yet possible to present a detailed statement giving an accurate account of the genesis, age, inter-relationship, and distribution of all the ore deposits in the State. So much remains to be done in the mapping of the various mining fields that such a statement is at the present time impossible. However, the work of this nature that has already been carried out is sufficient for the framing of tentative hypotheses to be rigorously tested in the light of future discoveries and investigations. The following short notes on the geology of the mineral deposits of South Australia should, therefore, be regarded rather as an account of the present state of knowledge with regard to them than as a final pronouncement based upon detailed investigations.

The Metalliferous Rocks.—The mineral veins which have been prospected all occur, without exception, in the lower Palaeozoic and Pre-Cambrian rocks which form the foundations of the State. Both Cambrian and Pre-Cambrian terrains are metalliferous; and the Jurassic sediments, which are the next in order of superposition of which the age has been definitely ascertained by palaeontological evidence, contain no metalliferous veins, nor do the sediments of still later date.

Evidence is being accumulated which appears to point to two distinct periods of mineralisation, the earlier in Pre-Cambrian and the later in Post-Cambrian time. It now appears to be certain that these periods of mineralisations were also epochs marked by invasions of acid igneous rocks. The relationship between some of the igneous rocks and the ore bodies is not well defined; but in the case of others the genetic relationship is most strikingly displayed. Some of the copper veins, notably those of Moonta and Eyre's Peninsula, are actually mineralised pegmatites.

Regarded as a whole, the State of South Australia is a metalliferous province in which copper is the predominant metal, but in which other metallic ores are in very many places associated with the ores of copper.

The general absence of tin ore is rather striking, since the lodes exploited in various parts of the State carry scheelite, wolframite, molybdenite, bismuth, arsenopyrite, with tourmaline and fluorite, and are closely associated with tourmaline-bearing granitic rocks. Yet the only discovery of appreciable amounts of tin ore hitherto made is that near Earea Dam in the Tarcoola district.

So far as the geological mapping of the mining fields has yet shown, no intimate connection between geological structure and the distribution of the ores can be detected. At least it may be said that no zonal arrangement of the mineral deposits has been recognised. There appears, however, to be some evidence that the workable uranium-radium deposits are restricted to areas in which notable metamorphism under conditions of great pressure has been developed, and that copper deposits are situated in the aureoles surrounding the centres of most intense metamorphism.

When considered with regard to the distribution of mineral deposits the State may be divided into three principal divisions—

- (1) The area occupied by the metalliferous rocks, comprising approximately 58,137 sq. miles. This area embraces all the elevated portions of the State—the Mount Lofty and Flinders Ranges, the Gawler Ranges, the ranges on the western side of Spencer's Gulf, and the Musgrave Ranges in the far north-western part of South Australia. The principal railway lines afford main lines of communication through a large part of this division, with the exception of those portions occupied by the Gawler and Musgrave Ranges.
- (2) The very large area, 139,876 sq. miles, in which outcrops of the metalliferous rocks are few, but over which the surface cover is a comparatively shallow mantle rarely exceeding 200ft. in thickness. While the distribution of the superficial cover and the general lack of topographic relief in this area render prospecting difficult, it is possible that discoveries of mineral deposits may be made within its limits. Some of the salt deposits of the State occur within this division.
- (3) The area occupied by the deep sediment-filled basins, comprising some 182,057 sq. miles. Within the limits of this division brown coal has been discovered at a number of points, and in it salt and gypsum also occur. But it is devoid of workable deposits of metallic ores. Many of the basins comprised within this division carry artesian or subartesian supplies of water, and the present state of knowledge with regard to these basins has been reached by the correlation of data obtained from the very numerous bores drilled in search of water.

Alluvial Deposits.—The number of alluvial deposits within the State is not large. The auriferous river gravels of present day streams are insignificant; but the undenuded remnants of a late Tertiary river system are more extensive. Few of these deposits have proved material contributors towards the mineral output; and, as far as is yet known, they cannot be counted on for future productivity. The filled basins of internal drainage contain a certain amount of mineral wealth in the form of salt and gypsum.

Coal and Lignite.—South Australia is less favorably endowed with coal resources than the other States of the Australian Commonwealth. Most of the beds are of inferior quality, and the best are remotely situated. Classified according to age, the coals and lignites of South Australia are to be grouped in three divisions—

- (1) The Jurassic coal of the Leigh's Creek basin. Possibly also the coal seams traversed by the Lake Phillipson bore are to be grouped here.
- (2) The Lower Cretaceous brown coal and lignite found in some parts of the Great Australian artesian water basin.
- (3) The Tertiary and Post-Tertiary lignite found at several localities in the southern parts of the State.

MINING.

The mines of South Australia are distributed through a very large portion of the State. In the known metalliferous areas many hundred square miles have yet received little or no attention from the prospector. The general prosperity throughout the State during recent years has been so pronounced that there has been a large demand for well-paid labor and little inducement for men to withdraw from the agricultural and pastoral districts, and carry on the arduous work of prospecting. Favorable prices on the metal market have not, therefore, in recent years, been coincident with a marked growth in the mining industry.

This is the more to be regretted as the agricultural development of the State has, during earlier periods of colonisation and settlement, followed closely upon mineral exploitation. The debt of South Australia to the mineral treasures of Moonta and Wallaroo, of Burra and Kapunda cannot be overestimated. Nor can it be said that the State has yet passed out of this stage of growth. Iron Knob has but recently been connected by rail with the sea coast, and the Transcontinental railway line will soon bring Tareeola within easy reach of Port Augusta. The railway communication of which the location has been determined by these mining centres will undoubtedly prove of great assistance to the pastoralists.

The exploitation of the mineral deposits in South Australia has been developed in the same order as in many other countries. The earliest period of activity was that in which operations were restricted to the precious and semi-precious metals. With the increase of population in the Commonwealth and the growth of knowledge of the State's resources the less highly-priced minerals have been turned to account, and it is safe to state that in the future steady advancement will be made in the establishment of new industries and the expansion of those already in existence.

COPPER.

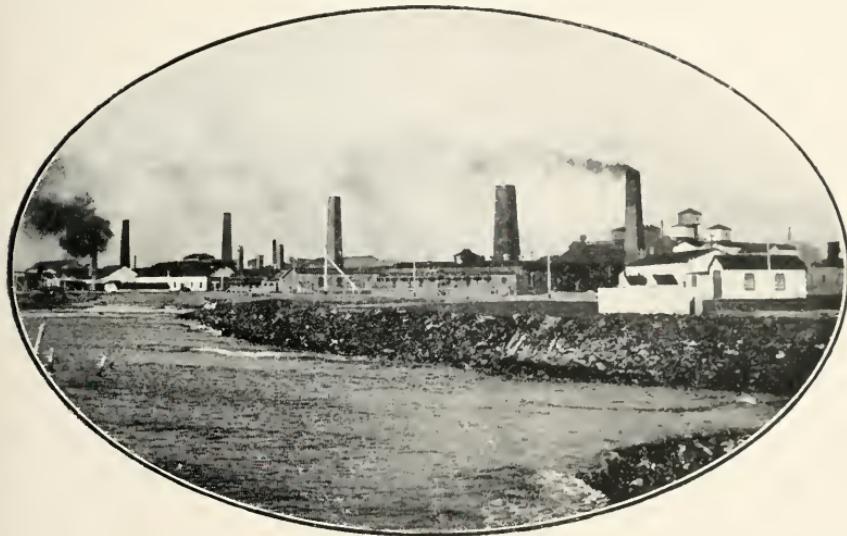
The oldest copper mine in the State is the Kapunda, which was discovered by Messrs. F. S. Dutton and C. S. Bagot in 1842. It is situated about 50 miles north of Adelaide, and was worked by the Kapunda Company until 1878, when, owing to an influx of water with which the pumping appliances of that date were unable to cope and the fluctuation of the copper market, the company ceased operations. About £1,000,000 of copper had then been obtained from this mine, which, on account of its purity, commanded a special price in the world's market. Since 1878 the mine has been full of water up to about 80ft. from the surface, and the only work done has been intermittent ore-stoping to the water level by tributers. The main shaft is 80 fathoms (480ft.) deep, there are numerous lodes strong and good under foot at the various bottom levels, and the reopening of this valuable mine is strongly recommended by official and other experts. The next South Australian copper mine to become celebrated was the Burra Burra, and the peculiarity and richness of its deposits made it world-famed. It was discovered by a shepherd in 1845, and is situated about 100 miles north of Adelaide. The mine stopped working in 1877; the large bodies of carbonate ore lying at shallow depths had been quarried out, but large and good lodes have been proved to exist beneath, and a second Burra Burra may be developed in the future from the lodes below the huge carbonate deposit. During the 29½ years the mine was in active work £2,241,167 was spent in general expenses; the output of ore during the same period amounted to 234,648 tons, equal to 51,622 tons of copper, worth at the average price £4,749,224. The original capital of the company was £12,320.

The Wallaroo and Moonta Mining and Smelting Company, with its extensive mines at Moonta and Wallaroo and large up-to-date smelting works at Port Wallaroo, ranks high amongst the large copper mines in the world; also the Moonta Mine, which for the first 30 years was worked independently, has the distinction of being the first mine in Australia to yield in dividends a total of £1,000,000, notwithstanding that the rich gold reefs of Victoria had been operated on years before Moonta was discovered. The Wallaroo Mine

was found in 1860 ; it is situated on the north end of Yorke Peninsula, about 10 miles northward from Moonta, and six miles east from Port Wallaroo. The Moonta was discovered in 1861, near the east shore of Spencer's Gulf, about 10 miles along the coast from Port Wallaroo ; the mines and the port are connected by the Government railway from Adelaide. At Wallaroo Mines the lodes strike approximately east and west.

At Moonta the general bearing of the lodes is north and south. The deepest shaft at Wallaroo is 2,310ft., and at Moonta 2,520ft. The country is monotonously level, and the lodes make no noticeable outcrops.

Up to date about £16,000,000 worth of copper has been extracted, and at the smelting works, in addition to the high-class copper of the well-known "Wallaroo" brand, sulphuric acid and bluestone are produced.



Copper Smelting Works, Wallaroo.

There are many other copper mines to which special and interesting reference could be made, notably, the Paramatta and Yelta (purchased by the Government in 1911), the Mount Lyell Consols, Wallaroo (Bingo), and the Hamley, on Yorke Peninsula ; the Balhannah, near the township of that name ; the Reedy Creek, or Kittieoola, near Palmer ; the Blinman, the Sliding Rock, the Yudnamutana, the Mount Fitton South, and the Parabarana, in the North ; and the copper section of the official "Record of the Mines of South Australia" (procureable free of charge at the Mines Office, Adelaide) contains the names and details as to the workings and prospect of about 500 copper mines and prospecting shows ranged all over the State within the limits mentioned therein, the majority being situated in the north country traversed by the Great Northern railway line.

The total copper production of the State from its foundation to the end of 1913 is nearly £29,000,000 in value, and the future of South Australia as a copper-producing country is hopeful.

GOLD.

The first find of gold was made in January, 1846, 10 miles north-east of Adelaide, near the Montacute. Expectations ran high, and a company was at once formed to work what proved to be, so far as can be ascertained, the first gold mine in Australia. Quartz mining was little understood in those days, and it is stated that after obtaining 24ozs. of gold, part of which was made into a brooch and forwarded to Her Majesty Queen Victoria, the company ceased operations. The Echunga Goldfield, situated about 18 miles south-east from Adelaide, was discovered in the early part of 1852. Gold was first found at the foot of a tree, laid bare by the dripping of water from the branches; $\frac{1}{2}$ oz. was picked up, and a good many ounces were afterwards obtained from the earth at the roots of this tree. The rich auriferous areas were not very large, but in 1871 an official estimate by the then warden of goldfields gave £300,000 as the value of the gold found on this field up to date. Since that time fossickers have occasionally made good finds. Some of the numerous quartz reefs in the district have been imperfectly tested to shallow depths. The Woodside group of gold mines, near the township of that name, is only a few miles north from Echunga, along the main range. Here a great deal of mining work has been done, and a considerable quantity of gold obtained. The principal mines are the Bird-in-Hand, the Two-in-the-Bush, the New Era, the Ridge, and the Eureka. None of these are at present working, the main causes of their idleness being want of capital and influx of water. From the Bird, which was the first mine started, and may be regarded in many ways as representative of the others, about £31,000 worth of gold has been obtained; the deepest shaft is 410ft. The last crushings of the original company, in 1889, were from the bottom levels, and 4,170 tons of stone yielded 2,776ozs. of smelted gold, or 13dwts. $7\frac{1}{2}$ grs. of gold per ton. This may be taken as a fair indication of the value of the reef, from 4ft. to 8ft. wide, untouched below the 350ft. level.

A number of other reefs in the vicinity have been tested, and encouraging results obtained from some of them. The Balhannah Mine is situated a few miles nearer the city and a mile from the Balhannah Railway Station. This is a remarkable mine; it ceased working in 1876 owing to an influx of water, with which the imperfect appliances then in use were unable to cope. It is known to contain large deposits of gold, bismuth, and copper, but the capital required for its proper reopening and systematic working is not yet forthcoming.

To the north of Woodside is the old Mount Torrens Mine, at which is situated the Government Battery and Cyanide Works, which were established in the central place of an auriferous district as an aid to the mining industry in providing convenient and economical means of testing trial parcels of stone and treating the ore raised by small holders and companies. It has proved of great value to the public, and so far 10,070 tons of stone have been treated for 5,880ozs. of gold, valued at £22,274. Northward again along the main range many mines have been worked and much gold won in the Blumberg and Mount Pleasant district; exceedingly rich specimens have been obtained here, and some of the richest samples of gold in quartz shown at the Jubilee Exhibition came from this locality. Barossa Goldfield—still to the north in the main range—is about eight miles east of the town of Gawler; it was discovered in 1868, and some of the claims were very rich. In 1871 an official estimate gave the value of the gold found on this field up to that time as £180,000. Nothing but desultory prospecting has been done for some time back.

Small quantities of rich ore have been obtained from the reefs, but attempts to work them as a whole have so far resulted in failure.

Gold has also been found at Ulooloo and Wonna, 140 miles north of Adelaide; thence north-east, Mount Grainger, Waukaringa, Mannahill, Wadnaminga, and Olary. It is in the north-east that the best find of alluvial gold yet unearthed in this State was made, at Teetulpa, in October, 1886. The place is situated about 200 miles north-east by north of Adelaide. The rich area was small, not exceeding a square mile, but it is estimated that £300,000 worth of gold has been obtained from it. There is a vast extent of similar country in this north-east land of large spaces, but up to the present Teetulpa remains the solitary rich patch located.

A Government Battery and Cyanide Works are erected at Petersburg, at the junction of the north and north-east railway lines, for the convenience of prospectors in those districts; 4,580 tons of stone have been treated for 4,208ozs. of gold, valued at £15,682.

At Tarcoola, about 300 miles north-west of Port Augusta, rich gold reefs were found in 1900. One mine, the Tarcoola Blocks, has crushed 30,929 tons of ore for 43,585ozs. of gold, valued at £131,665. The great distance of this place from the settled districts has made mining very expensive and difficult. A Government Battery and Cyanide Plant is also established here, and 3,801 tons of stone have yielded 5,482ozs. of gold, valued at £19,340. At Glenloth, about 50 miles south-east from Tarcoola, are numerous gold-bearing reefs; the battery there—recently taken over by the Government—has crushed 1,832 tons of ore for 1,936ozs. of gold, valued at £6,498.

Immense areas of likely and unprospected country exist in this north-west district. Gold has also been found in the Peake and Denison Ranges and near Yudnamutana, at the north end of the main range.

SILVER-LEAD.

The first mineral to which the attention of the early settlers was called was silver-lead, and this happened by the breaking down of an outcrop of galena on a spur of the Mount Lofty Range near Glen Osmond, three and a half miles south of Adelaide, by the wheel of a passing dray. The glittering ore was thus exposed, and the State's first mine, named the Wheal Gawler—after the then Governor, Colonel Gawler—was started in May, 1841; indeed, it is practically certain that this mine is also the very first mine ever worked in Australia.

There are numerous lodes here, small, as compared with those of the Barrier, but giving high percentages of lead and a fair amount of silver. For instance, the O.G. lode produced galena and carbonate of lead of an average value of 21ozs. of silver per ton and 71 per cent. lead. It was worked by an English company from 1847 to 1850, during which time it yielded £30,000 worth of silver and lead. The Glen Osmond group of mines ceased work on the outbreak of the Victorian gold diggings, in 1851. Little has been done on them since the early days, and nothing at all during the last 17 years. From the city the old dump heaps can be seen. The old smelting works chimney is a well-known landmark.

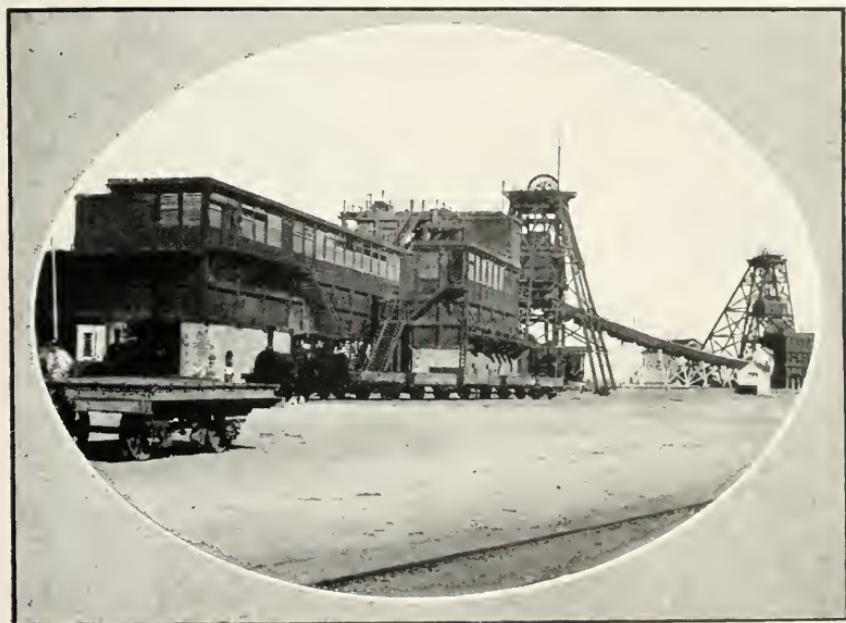
The Talisker Mine is the most southern one in the State, being situated about three miles east of Cape Jervis. It was opened in 1862, and worked for 10 years, during which time the gross proceeds of the silver-lead sold amounted to £29,866, but want of capital compelled cessation of operations in 1872. There is a series of lodes on the property, but only one, the Talisker, was worked upon. It varies in width from 1ft. to 22ft., and consists of quartz, arsenical pyrites, indurated slate, and galena, very suitable for concentration. The lead, according to the old records, carried on an average 1oz. of silver per unit. The deepest shaft is 432ft. Several small attempts have been made to rework this valuable property since the original company stopped, but in each instance the amount of funds raised was quite inadequate. The mine is situated in timbered country, and is close to the sea.

Northward from Cape Jervis along the main range and south-east from the city are many silver-lead mines, notably the Aclare, Almanda, Kangarilla, old Strathalbyn, and Scott's Creek, from which good returns were obtained in the early days, but upon which nothing beyond a little intermittent work has been done since.

Numerous other veins and lodes of galena are also known to exist throughout the hills district.

In the north-east, mainly in the vicinities of Mannahill and Olary, many shows have been prospected with varying results.

In the north the most important deposit of silver-lead ore, so far as known at present, is at Ediacara, about 17 miles west from Beltana Railway Station. The ore-bearing bodies are almost horizontal; at one place a shaft or drive, at a distance of 400ft. on the underlie, is only 70ft. from the surface. Work, with varying success, has been carried out on the large ore bodies here for about 20 years. There is a considerable area of metalliferous country in this locality, which will doubtless be prospected and proved in the near future.



Crushing and Sorting Plant at Wallaroo Mines.

At Avondale, 15 miles east from Lyndhurst Siding Railway Station, a large quantity of very pure galena has been obtained from time to time, the deepest shaft being 140ft. About 50 miles to the north-east of this place, at the Duck Ponds, Freeling Waters, a good lode, named the Gilead P. Beck, has been prospected, but only to a shallow depth. Veins and outcrops of silver-lead ores, so far unworked, exist in many other places in the North.

In the latter part of 1912 an important discovery of exceedingly rich silver-lead ore was made at a locality situated 18 miles to the west of Cowell. This ore contains a large proportion of silver chloride, and various samples returned

assays of over 2,000ozs. of silver per ton. Little work has yet been carried out upon the lodes, but this discovery has attracted attention to a mineralised region, and further prospecting may be expected to result in the location of productive mines.

Little has been done in silver-lead mining recently, and the value of that class of ore marketed during the last 10 years is small.

IRON.

Iron ore occurs to a greater or lesser extent throughout South Australia, except in the South-East district. Large workable deposits have been found from near Port Victor, in the south, to above Quorn, in the north; also in the North-Eastern district and in the country west of Port Augusta. The largest deposits in the State are those situated at Iron Knob, 41 miles west-south-west of Port Augusta. There are at this spot two great ore bodies which are known as the Iron Knob and the Iron Monarch. The former only has been worked and has already provided nearly 700,000 tons of ore for fluxing purposes. This iron ore has been shipped to the smelting works at Port Pirie by the Broken Hill Proprietary Company, and its average content of metallic iron has been found to be over 68·5 per cent. A trial shipment of 2,000 tons of ore from this place was forwarded to England by Messrs. Elder, Smith, & Co. in 1907. All reports received concerning the parcel were good; it was found to contain 97 per cent. iron oxides carrying 68 per cent. metallic iron, and was disposed of in Scotland at a satisfactory price; but over-sea freights proved too high to admit of continuous business.

The Iron Monarch has not yet been opened up. It is a much larger body than the Iron Knob, the extent of its outcrop being a little over 50 acres. On the southern and eastern sides of the Monarch—which is a dome-shaped hill rising to a height of over 600ft. above the surrounding plain—massive ore outcrops in rough crags. The general average quality of the ore is high. A little manganese occurs in parts of the outcrop, but may not persist in depth.

The quarries on the Iron Knob afford exposures which indicate a deep-seated origin for the ore which consists principally of haematite. It appears probable that the concealed portions of the Iron Monarch will exhibit similar characteristics when opened up. At the present time no exact idea of quantities can be formed since all calculations must be based on assumptions with regard to the subterranean extension of the ore. A contour track has been cut round the southern end of the hill, which rises to a height of 286ft. above this track. A shaft has been sunk in ore on the eastern flank of the deposit to the level of this track and ore outcrops on the hill flanks at somewhat lower levels. On the assumption that the average depth of ore is no more than 100ft., the deposit

contains 20,000,000 tons of ore. It may at least be said that the Broken Hill Proprietary Company should be able to so plan the work of production as to adjust their output to the economic demand rather than to the supply of ore.

Preparations for the treatment of the ore have already been put in hand and it is expected that the work of production will commence early in the year 1915. Unfortunately for South Australia, the lack of suitable supplies of coal within the State has compelled the Broken Hill Proprietary Company to establish the iron works at Newcastle, in New South Wales.

Near Oodlawirra and Cutana, on the North-Eastern railway line, large quantities of iron ore were quarried and forwarded to Broken Hill for fluxing purposes at the time when the smelting operations were carried on there; and at Koolka, on the Bimbawrie run, large outcrops exist which, so far, remain unworked. A valuable and extensive deposit, known as Donnelly's Quarries, is situated about 11 miles northward from Quorn Railway Station. There are five chief outcrops, and a considerable quantity of ore was forwarded to Port Pirie before the Iron Knob was opened up. About half a million tons are readily available here.

A lode containing haematite ore of fair quality has been opened up in the neighborhood of Williamstown, 22 miles to the north-east of Adelaide. This mine, known as the Mount Bessemer Iron Mine, has been worked superficially for about 40,000 tons of ore sold as flux. It is estimated that about half a million tons of ore are to be obtained from that part of the mine which is above the level of the surface drainage of the district.

At Peralilla and Mount Jagged, near Port Victor, large quantities of ore are obtainable. In 1873 small smelting works were erected at Mount Jagged, and pig iron was produced by means of locally-made charcoal. From Burra and Gum Creeks flux was obtained for the Burra Mine smelters in the early days. There are numerous other deposits in various parts of the State.

RADIUM.

Two districts in the State contain deposits which are being worked for their radium contents. Both are to a considerable degree hampered by the remoteness of their position.

The Radium Hill field, which lies to the southward of the Broken Hill railway line and near the eastern boundary of the State, is, perhaps, the more advanced. One company has been for some time sending regular shipments of concentrates to Sydney, where the radium is extracted from the ore. The refined radium bromide has already been marketed and the stage of regular production has been reached. Two other mines in this field contain ore of somewhat similar character, and developmental operations are being carried

out with the object of proving the extent of the deposits. The ore is of rather exceptional character, containing ilmenite, magnetite, haematite, ferriferous rutile, traces of iron and copper pyrites, biotite, mica, and quartz. Traces of pitchblende have been recorded at one spot. The visible radio-active minerals are carnotite and autunite; but the ferriferous portions of the lode in which these secondary ores are not discernible have also been proved to contain uranium and radium.

At Mount Painter, in the Flinders Range, 65 miles east of Farina and 32 miles from Lake Frome, secondary ores only have been exposed. Small parcels of ore containing a high proportion of autunite and torbernite have been exported together with larger parcels of lower grade ore. The development of the mine is proceeding with satisfactory results. The area surrounding the principal workings is already known to carry disseminated autunite and torbernite, and it is not unreasonable to expect that more extensive prospecting will reveal the occurrence of other workable deposits.

Traces of radio-active ores have been found at Moonta and near the Yeldulknie reservoir on Eyre's Peninsula, but not in sufficient amounts at any spot hitherto located to justify further prospecting.

PHOSPHATES.

The existence of mineral phosphates in South Australia has only been lately demonstrated. In order to stimulate the search for deposits of phosphate rock within the boundaries of the State, a reward for its discovery in workable quantity was offered by the Government. This bonus was successfully claimed for the Clinton discovery at the north-eastern end of Yorke Peninsula, and since then phosphate has been found in many other places. The rock is found almost invariably in connection with the crystalline limestones and other rocks belonging to the Cambrian system. In some cases it appears in deposits apparently filling in cavities in the limestone, and in others it is partly interstratified with the soft argillaceous rock which accompany the limestone. In all cases it occurs in segregated masses, boulders, and nodules. Numerous deposits exist, and the occurrence of rock phosphate at intervals has been demonstrated for about 200 miles along the main range from Mount Magnificent, in the south, to Bendleby, in the north, the averages of the highest and lowest analysis being 69 per cent. to 42 per cent. tricalcic phosphate. These deposits are already of economic value, about 54,000 tons of crude rock having been marketed since the first discovery. They are not yet able, however, to successfully compete with the imported rock from Christmas and Ocean Islands, but we may with every confidence look forward to the time when they will be of the greatest importance and value, not only to the State of South Australia, but to the Commonwealth generally.

COAL.

With regard to coal, from time to time announcements have been made of supposed discoveries of coal, which in most instances have proved to be, at best, merely Tertiary lignites of no value for fuel. In two cases, however, namely, at Kuntha Hill, 110 miles north of Hergott, and at Leigh Creek, on the northern railway, a better class of brown coal has been found. At Leigh Creek, near the centre of the basin, at a depth of 1,496ft., was struck a coal seam 47ft. 10in. in thickness; coal seams 2ft., 3ft., and smaller were met with below. A shaft was sunk nearer the edge of the basin, and a considerable amount of coal raised from a depth of 300ft. The coal seam worked is 7ft. in thickness. Some 12,500 tons were raised, and of these 8,000 tons were sold. But this attempt to exploit the resources of the coalfield was unsuccessful, chiefly because the coal tends to disintegrate on exposure to the atmosphere. No exhaustive experimental work has yet been carried out with a view to the manufacture of briquettes from this coal. At Lake Phillipson, about 320 miles north-westward from Port Augusta, a bore was sunk for the purpose of testing the country for artesian water, and several seams of brown coal similar to that of Leigh Creek were met with at intervals from 166ft. to 551ft. These varied in thickness from a few inches to 28ft. From 551ft. downwards the bore passed through blue shale, with occasional thin sandstone, grit, and calcareous bands. This shale was more or less bituminous at intervals to about 2,240ft.

At Kuntha Hill, which is very remotely situated, being 110 miles from the railway line, three shafts and two bores were put down by a company formed to prospect the property, the depths of the former being respectively 70ft., 84ft., and 150ft., and of the bores 298ft. and 112ft., and three seams of coal were passed through 2ft. 6in., 2ft., and 5in. in thickness.

Near the township of Noarlunga a lignite deposit, 14ft. thick, has been worked upon. It consists of a brown coaly shale containing carbonised wood, compressed leaves and resin, with small seams and bunches of brown coal of good quality. It is possible that richer beds exist in the locality, but so far boring has not located them. Other beds of lignite are known to exist in the vicinity of Adelaide, Moorlands, and Bower, but none have been worked.

VARIOUS METALS AND MINERALS.

Manganese ore of high grade has been found in many places. The chief localities where mines have been worked are near Willochra and Gordon in the north, and near Tumby Bay on Eyre Peninsula.

Cobalt, in small quantity, generally accompanied by nickel, has been found at various places, and is frequently associated with copper lodes. Rich cobalt ore has been taken from time to time from Cooke's Cobalt Mine, situated about eight miles northward from Bimbawrie.

Gypsum occurs at intervals throughout the State from Lake Alexandrina to Lake Eyre. Large and readily worked deposits, from which the present supplies for local use and export are drawn, exist at Lake Fowler, and near Marion Bay, Yorke Peninsula.

South Australia is well provided with salt, and the industry is steadily growing. About 500,000 tons of crude salt have been scraped during the last 10 years, and the exports, both of refined and crude salt, are large and increasing. The chief sources of supply are the salt lakes of southern Yorke Peninsula, of which Lake Fowler is the largest, and Lake Bumbunga, in the hundred of Cameron. There are also valuable salt lakes on Kangaroo Island, notably in the hundred of Haines. Lake Hart, about 60 square miles in area, situated about 120 miles north-west from Port Augusta, contains immense supplies of salt of good quality, which at present, owing to the distance from a market, is of no economic value. The Castle Salt, the Standard Salt, and the Commonwealth Salt Companies are in active operation. Most of the salt exported is shipped from Edithburgh, near the south-eastern corner of Yorke Peninsula.

Tin has so far been only found at one place in the State, namely, near Earea Dam, about 30 miles south-east from Tarcoola, or about 260 miles from Port Augusta. The find was made in a mud lake bed, the tin oxide occurring in decomposed granitic dykes and in veins and bunches of quartz; tin ore has also been found in shafts in the sandhill country adjoining. Nothing but general and desultory prospecting has been done, but the possibilities of the place are great.

Traces of tin have been detected in vein matter consisting essentially of magnetite and quartz found at Booleoomatta in the north-eastern portion; but the quantities thus recognised are so small that they can only serve to draw the attention of prospectors to the necessity of the examination of other iron-bearing lodes in this region for tin.

Large deposits of china stone (silica and felspar), pure quartz, felspar (hard and decomposed), and firebrick clay are found at Hog Bay, Kangaroo Island. The Kangaroo Island China Stone and Clay Company has erected brickworks for the manufacture of firebricks at Hog Bay, and a crushing and grinding mill at the mine. All the materials for high-class pottery exist here. There is no doubt as to their purity and suitability, nor of the large quantities readily available. At this place, also, erratic poekets of very fine tourmalines have been unearthed from time to time. The varieties found, which may be regarded as gems, include pink tourmaline (rubellite), blue tourmaline (indicolite), and green tourmaline. Two different colors are often associated in the same crystal—the green crystal having a pink centre, and the blue and green colors showing in the same crystal.

Monazite sand in small quantity has been found in the Eleanor River, Kangaroo Island; in the hundred of Para Wirra, near Adelaide; at King's Bluff, in the north-east; and near Mount Painter, in the north.

No gem discoveries of importance have been made, although more than 50 good saleable diamonds have been found in the Echunga district since the first discovery of gold there many years ago. The best one was known as Glover's diamond, and was valued at £70. Small sapphires and other gems have been found near Williamstown.

Corundum occurs in mica schist at a number of places in the country surrounding Mount Painter. Semi-transparent fragments of various colors have been found in this district; but the remoteness of the locality and the low average rainfall militate against the working of the massive deposits and the derived gravels.

Alunite has recently been discovered in the neighborhood of Normanville.

Barytes is widely distributed throughout the State, and many of the deposits contain exceptionally pure ore.



View in Botanic Garden, Adelaide.

AGRICULTURE.
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IN value of production cereals take first place in South Australian agriculture, over 3,000,000 acres being under crop in 1912-13. Wheat is the principal cereal grown, there being 2,100,000 acres cropped in 1912-13 for an average yield of 10·34bush. Of barley an average yield of 19·12bush. was obtained from 72,000 acres, while 316,000 acres sown to oats averaged only 10·76bush. per acre. Of cereal hay 705,000 tons were gathered from 610,000 acres.

Apart from the very large areas of new country being opened up for settlement by means of railways the official statistics show that in the aggregate about 12,500,000 acres of land suitable for cereal production is at present occupied. It is interesting to note that in proportion to population this state has the largest area under cultivation, viz., 7·12 acres per head of population as against 3·92 acres in Western Australia, 2·95 acres in Victoria, and 2·10 acres in New South Wales.



Farming in South Australia.

Over the greater part of the wheat-producing areas the rainfall is comparatively light. Speaking generally, there are only two distinct seasons, i.e., winter and summer; autumn and spring as definite periods being difficult to define. From April to October approximately three-fourths of the annual rainfall is recorded. The winters are comparatively mild, extreme cold being experienced for but short periods, except in the high lands. The summer is warm and dry with occasional hot spells.

The following figures give the average monthly rainfall and the approximate wheat yield of six important wheat centres, and will convey a good idea of the rainfall in its relation to the wheat crop:—

Table showing Average Monthly Rainfall, Rainfall during Growing Period, and Average Yield of Wheat per Acre in typical Wheat Areas.

Location. Monthly Rainfall.	Roseworthy.	Saddleworth.	Maitland.	Jamestown.	Pinnaroo.	Tumby.
January	In. .89	In. .80	In. .62	In. .66	In. .27	In. .28
February .....	.51	.66	.47	.61	.92	.47
March .....	.88	1.06	.95	.88	1.40	.75
April .....	.77	1.84	1.92	1.40	.70	1.43
May	1.85	2.18	2.48	1.73	1.92	1.67
June	2.69	2.66	3.25	2.37	2.43	2.38
July	1.91	2.29	2.61	1.97	1.65	2.22
August	2.06	2.39	2.47	2.09	2.14	1.86
September	1.73	2.09	1.84	2.04	2.09	1.50
October	1.66	1.70	1.73	1.64	1.11	1.16
November	1.01	1.15	1.02	1.08	1.17	.82
December .....	.78	.89	.72	.99	.94	.46
Total	17.71	19.69	20.08	17.46	16.74	.15
Rainfall during growing period	12.91	14.46	15.40	12.92	12.51	11.61
Average yield per acre	Bush. 14.15	Bush. 17.18	Bush. 16.17	Bush. 17.18	Bush. 10.12	Bush. 10.11

These averages cover the returns from the whole of the land cropped in the respective districts, and it is safe to say that for well-prepared land the average would be at least 3bush. per acre higher. The Roseworthy College Farm results afford proof of this fact—the average wheat yield for the past nine years, including all the experimental areas, is between 18bush. and 19bush., against the district average of 14bush. to 15bush.

Seeding takes place during the months of April, May, and June, and harvesting during November, December, and the early part of January, according to the district. While the May to November rainfall is taken as the fall during the growing period, a fair proportion of the May rain falls before the bulk of the crop is in the soil, while in the earlier district the November rain generally has little effect on the crop.



Harvesting Hay for Ensilage, Roseworthy Agricultural College.

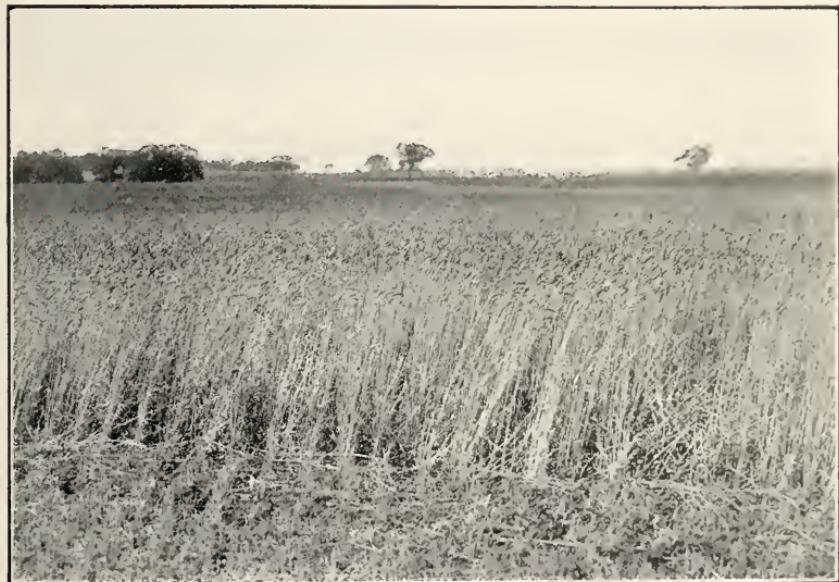
GOVERNMENT AID TO PRIMARY PRODUCERS.

In South Australia the State assists the primary producer in many ways, and various institutions are maintained by the Government for educational and experimental purposes. Produce of all kinds is handled, prepared, packed, and exported by the Government Produce Department.

Experts on agriculture, horticulture, viticulture, apiculture, dairying, poultry-raising, veterinary science, and so on, have been appointed. These officers are attached to the Agricultural Department, and may be consulted without fee. Lectures are delivered by them and courses are conducted at the School of Mines and the Agricultural College, as well as in country districts. Advice is given to intending selectors of land, soils are analysed and constituents explained.

AGRICULTURAL COLLEGE.

While most of the other States were devoting a great deal of attention to the development of mining fields, the authorities in South Australia, undisturbed by any feverish excitement, were focussing their attention on the development of agricultural lands, and the evolution of scientific farming. Realising that the soil yielded its best returns only to men who brought up-to-date scientific methods into operation, it was determined that intending agriculturists should be given every reasonable opportunity to acquire a thorough technical education on the agricultural side. Consequently an agricultural college was established, 30 miles north of Adelaide, for the two-fold purpose of training young men for the practice of agriculture, horticulture, and viticulture, and to conduct experiments with a view to the advancement of the rural industries in South Australia. Special attention is devoted at the College to " diversified farming," and valuable experiments are carried out in livestock-breeding, poultry, and dairy farming.



Field of Wheat, Lower North Agricultural Areas.

It is impossible to over-estimate the beneficial influence exercised by this college upon the agricultural industry of the State. Many who have passed through it are to-day amongst the most prosperous of our farmers, while some are holding important positions in connection with other agricultural institutions.

The curriculum at the college is as follows :—First year—Agriculture, chemistry, book-keeping, veterinary anatomy, physics, botany, mathematics,

and English. Second year—Agriculture, viticulture, fruit culture, chemistry, surveying, dairying, veterinary physiology, physics, and wool-classing. Third year—Agriculture, viticulture, fruit culture, chemistry, surveying, dairying, veterinary science, aviculture, and wool-classing. The fees are £30 per annum, payable *pro rata* at the beginning of each session. Arrangements can be made for special six-month courses in dairying and aviculture.

Six scholarships, each of an annual value of £30, tenable for three years, are offered for competition each year. Competitors must be boys of not less than 16 nor more than 19 years of age on the 1st April of the year in which they compete, and must not have been already in attendance at the college.

EXPERIMENTAL FARMS.

Experimental farms occupy a distinctive place in the agricultural education of South Australia. There is no more potent way of influencing the practice of a district than by the establishment of plots under capable and reliable management, either on the part of a departmental expert or on the part of an experienced and well-trained farmer acting under such direction. The Government has brought to the assistance of agriculturists excellent facilities for imparting valuable information.

The experimental farms which are distributed throughout the State perform work comprising two sections—demonstration work on private farms and experimental operations on State farms. The demonstration blocks have been confined to (1) wheat variety tests; (2) complete *v.* incomplete manurial tests; (3) hay tests; (4) feeding-off experiments; (5) potato experiments; (6) fodder crops.

The experimental farms in the control of the department are—in connection with Roseworthy College there is a farm of 1,500 acres; Kybybolite contains 2,300 acres and is the headquarters of the Superintendent of Agriculture in the South-East, and experiments of a general character, dealing specially with conditions in that part of the State, are conducted.

At Turretfield there are 1,600 acres devoted to a seed wheat station. The department is utilising 30 acres of beautiful alluvial land for working up problems in irrigation from the Para River.

At Veitch's Well a farm of 4,600 acres has been established to assist settlers in the exploitation of a wide range of country south of the Murray and between the river and the overland line, where the average rainfall is only 10in. to 12in.

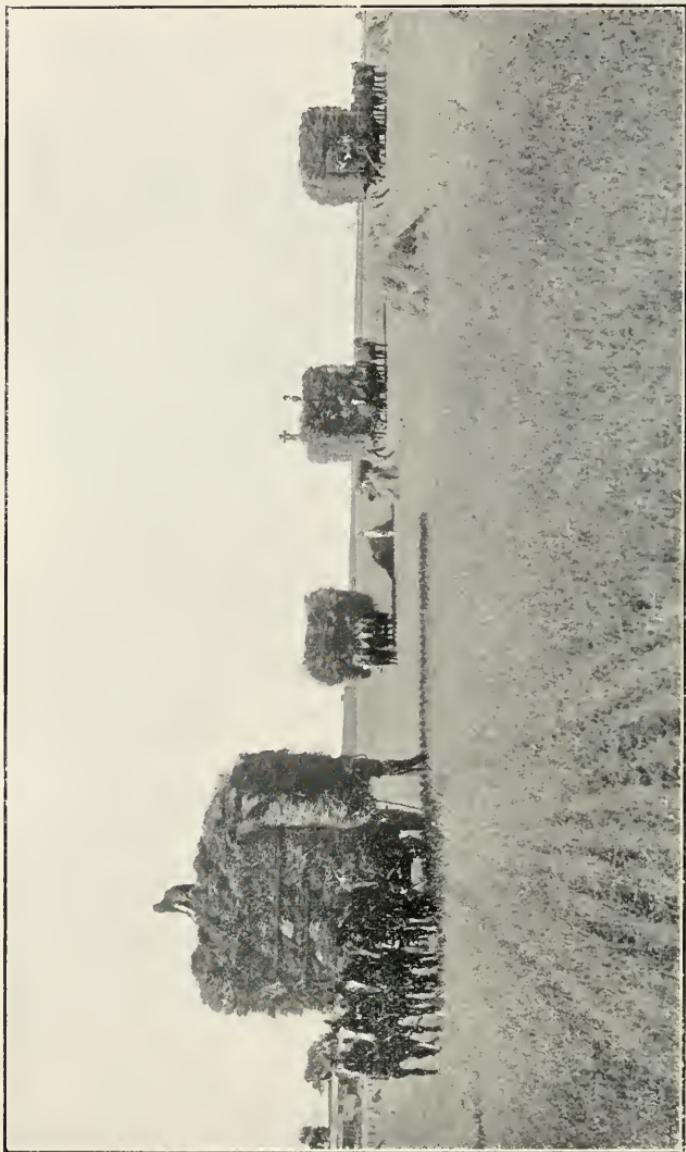
At Booborowie 1,300 acres have been secured for a seed wheat station serving the Northern Areas, and as a training farm for town boys, to give them, if possible, a taste for farm life and a good start towards becoming efficient farm hands, and in course of time, by diligence and thrift, as farmers of their own blocks of land.



Seeding Operations.



Hay Stacks.



Hay Carting on Lower North Farm.

THE POSITION OF AGRICULTURAL PRACTICE IN THE STATE.

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IN South Australia, as elsewhere, the practice of agriculture varies with such determining factors as quality of soil, rainfall and climate, transport facilities, and market demand; and as these factors vary widely within the far distant limits of the agricultural areas there is consequently a corresponding diversity in the practice of farming.

The average annual rainfall, for example, of respective extensive areas ranges from 10in. to 11in. in the northern districts and districts away from the coast to 30in. to 35in. or more in the moister regions of the south and in the areas of higher elevation proximate to or situated in the ranges of hills. Where the rainfall is heavier, stock-raising and the concomitant growth of forage crops, dairy farming, fruit-growing, more or less intense culture, and market gardening obtain. On the rich, volcanic soils of the South-East, for example, a wide rotation of crops can be grown. Potatoes and onions are extensively cultivated; the cereals—wheat, barley, and oats—return very heavy yields; leguminous crops such as peas, and forage crops such as mangolds, rape, or kale, are being sown more extensively as a means of increasing the carrying capacity of the farms, maintaining the fertility of the land and helping to keep it clean; and on limited areas grasses, clovers, or lucerne are sown for temporary or permanent pasture, though the rapidity with which such land becomes covered with a sward of indigenous grasses, trefoils, clovers, and adventitious herbage of high grazing value to some extent discounts the practice of seeding down pastures. On these lands farming practice is to some extent modelled on British practice, but is necessarily much modified to meet the position economically so different.

The Economic Position.—To make it evident how very considerable this modification must be, it is only necessary to contrast the relative economic positions. For example, the wages of farm labourers rule at approximately double the rates paid in the old country. Artificial manures cost 50 per cent. more, and for plant and implement equipment a correspondingly high price prevails. The value of wheat and other produce for shipping is, of course, lower by an amount for freight charges and profit—say, in the case of wheat, 25 per cent. lower—and fat stock, e.g., cattle, sheep and lambs for freezing and export are worth in the local market only about one-half the value of similar stock in England. In the case of wool and dairy produce and other products of higher value for a given weight or bulk the handicap is, of course, very much lighter, as freights in proportion to the value of the product are relatively small. On the other hand, land values are much lower here: the quantities of manure required per acre are much smaller, and expensive nitrogenous manures are not demanded, save to a very limited extent;

taxation is considerably lighter; and the dead winter season of Britain, with all its attendant costs in the provision of fodder, handling of stock and shelter is practically escaped in this climate; while for the same reason—climatic conditions—expensive improvements, such as under-drainage of land, are unnecessary.

Thus, while our farming on the lands of highest capacity may be based on traditional British practice, there must of necessity be marked modification. Crops, such as sugarbeet and flax, requiring much hand labor, must be passed, and, labor-saving machinery being indispensable, those crops admitting of its use in greatest degree are consequently most in favor. Altogether, on the lands of highest capacity and of high value per acre, dairying is the predominant feature and one of the best means of utilising them; but, as such lands are generally occupied in smaller holdings, and the owner, with his family, furnishes most of the labor, certain crops for local or Adelaide markets, such as potatoes, onions, and market garden products, are also extensively grown.

Between such lands of highest quality and the marginal areas of lowest average farming capacity—the drier areas, where the rainfall (10in. to 12in. per annum) and not the quality of the soil is the limiting factor—may be graded the farming lands of the State, representing varying degrees of quality and capacity, but, for the most part, fine wheat-growing lands.

The Wheat-Growing Areas.—Wheat was the crop favored by the pioneers of settlement. It is still the crop greatly predominant, and no doubt will continue of first importance, as it is peculiarly adapted to the conditions of soil and climate prevailing, and allows of labor-saving appliances in every process of its culture.

The practice generally adopted is to crop the land with wheat once in three years, thus—

1. Wheat.
2. Grass self-sown, and adventitious herbage.
3. Fallow.

But this rotation is variously modified according to locality and conditions of rainfall. Forage crops are being introduced with success and with advantage to the land in the maintenance of humus where the rainfall is 17in. or over, and where, owing to the higher value of the land, the proportion of bare fallow has to be reduced, that a bigger flock of sheep may be maintained. The improved prospects of the frozen meat industry and the prices lately ruling for wool have encouraged this development now being tentatively followed, and of which a rapid extension, making for greatly increased returns from the wheat-growing lands, is anticipated. The above rotation may be variously modified therefore, according as the autumn rains supervene early

or late. In an early season, when good soaking rains fall in the end of March or first days of April, there is an opportunity to seed considerable areas with such crops as rape, Italian rye grass, barley, or oats, to be grazed, but in a late season the farmer is becalmed by dry weather, the land being too hard and too dry for satisfactory tillage. From the end of April to the beginning of June all his attention and the full strength of his farm must be given to the seeding of his fallowed land with wheat or other cereal, but for the most part with wheat. Accordingly, forage crops not requiring an early start, such as peas or Cape barley, which can be sown with good results later, must be put in as an alternative when the cereal seeding operations have been completed. There is thus no definite or relatively hard and fast rotation practicable, but on the more favored wheat areas, the trend of practice is toward a system of cropping in which the proportion of bare fallow is diminished and that of forage crops increased, and which may be set in skeleton thus—

1. Wheat after fallow.
2. Peas, rape and mustard, barley or oats for forage.
3. Wheat or oats for hay or grain, or barley for grain.
4. Stubble herbage—self-sown grasses, various trefoils (*genus medicago*), geranium, and other adventitious herbage, to be grazed.
5. Fallow.

Power Tillage.—The main objection to some such system of increased forage cropping is the fact that additional horses must be kept to meet the pressure of work for April, May, and June, but which will not be required during the rest of the year. It is therefore in this connection that the need of motor power for tillage implements is most evident. Early seeding is essential for the best results with forage crops; they must be germinated and well established before the cold, water-logged conditions prevailing after mid-winter have supervened, for otherwise they will make little progress until the spring, and their growing period will be altogether too much fore-shortened. Accordingly, there is no doubt that the facility with which large areas can be overtaken promptly on the heels of the autumn rains by means of motor tractors will create a demand for such power plant, and as these tractors become improved and adapted to the conditions, so will the area under forage crops be increased.

In the drier inland districts—11in. to 14in. of rainfall average—where the land is relatively cheap and the holdings necessarily of much greater area, the three-years system is also modified in favor of better grazing. Two crops are taken in succession after fallow fairly generally, as the land after the second crop is not so clean, and the grasses, trefoils, and herbage that spring up in the stubble in the following year come more thickly, leaving less land bare,

and consequently carry more stock. A thorough fallowing of such land once in three years is severe on the humus, tends to make the soils in some districts too open and liable to drift and, as it is a characteristic of these arid districts that the sward of moister regions does not exist, as the grasses, &c., grow in tufts and are sparsely planted, it also tends to leave the surface too bare of vegetation. Accordingly, the rotation most generally followed is this—

1. Wheat after fallow.
2. Wheat or oats after wheat.
3. Stubble, herbage, trefoils, and grasses self-sown.
4. Grass and herbage.
5. Fallow.

In these districts, where the average rainfall is so close to the minimum for possible wheat culture, failures are recurrent, and occasional complete failures occur on the fringe of settlement, as must be anticipated. Nevertheless, when the rainfall exceeds the average the soils, as is characteristic of arid country, are relatively so rich in the elements of plant nutrition and the conditions all round are so favorable that relatively very heavy crops, in view of the total rainfall, are reaped that atone for past disappointment, and when a man holds a sufficiently extensive area to combine grazing sheep with wheat-growing the position is economically sound. Strange it may seem, yet when the total wheat from these areas is reckoned up over a series of, say, 20 years, it is found that a very considerable percentage of South Australia's wheat has been drawn from these very districts, uncertain though they be.

Low Cost of Production.—The average yield of wheat for the whole State—8 bush. to 13 bush. per acre according to the season—relatively to some other wheat-growing countries is low, but these figures are nowise to be taken as an index of the position from a profit and loss point of view of wheat-growing compared with the results of other countries. They must, of course, be considered in relation to the cost of production, which is exceptionally low. All the conditions allow of the extensive use of labor-saving machinery—multiple furrow ploughs, four to six furrows on the heavier lands and up to 12 or 14 furrow twin ploughs on the lighter lands, 8 to 10 horse cultivators, 17-hoe drills, sets of harrows of eight leaves, and harvesting implements such as the stripper or the complete harvester, by which the grain is stripped, winnowed, and bagged in the field, leaving the straw *in situ*, so that the cost of tillage and other operations is reduced to a very minimum with which few places in the world can compare. The farms are subdivided into fields of larger area—40 acres to 200 acres or over—and allow of long lands, and the conditions of the soil in respect of water and going of teams admits of harnessing 8 or 10 horses abreast to the large implements without danger of puddling the soil. Accordingly every facility exists for cheap tillage,

and it is possible, for example, for one man with a team of 8 to 10 horses, and with the latest and most improved implements to do all the work necessary—fallowing, cultivating, and cleaning the land, harrowing and surface tillage, seeding and manuring the crop, and reaping the harvest from 200 to 240 acres of wheat, with the exception of some assistance in harvest time. Even at the low yields, therefore, one man may produce by his own unaided effort from 1,800 bush. to 3,000 bush. of wheat, and, under favorable conditions, with the assistance of a lad, his output may reach 5,000 bush. Other factors which make for low cost of production are—

- (a) The fact that, when fallowing has been thoroughly and efficiently executed and tillage adapted to the conservation of moisture intelligently conducted, nitrogenous manures are not required, and only light dressings of soluble phosphates—generally mineral superphosphate—from 80 lbs. per acre to 2 cwt. per acre, according to the district, are necessary to secure the maximum crop of which the rainfall and length of growing period admits. The summer temperature being so favorable to ferment activity in the soils, the absence of leaching of nitrates by excessive rains and the nitrogen gathering influence of the burr clovers or trefoils that come self-sown on the stubble seem together to maintain the supply of nitrates adequately.
- (b) The beneficial results to be obtained by light dressings of soluble phosphates. A dressing, for example, of $\frac{1}{2}$ cwt. per acre of superphosphate drilled with the seed will increase the yield of wheat often from 4 bush. to 5 bush. per acre, while 1 cwt. per acre may augment the yield by as much as 7 bush. per acre. The general experience is, almost throughout the State, that the use of superphosphates with the seed results in increased returns several times the value of the manure applied, and accordingly the application of superphosphate has become almost universal. The yield of wheat in the State has been increased upwards of 30 per cent. to 40 per cent. or more by this comparatively inexpensive means, and much land has been brought within the margin of cultivation which otherwise could not have been farmed profitably. The quantity of superphosphate used in the State annually is over 90,000 tons, and it is proving more and more an important factor in lowering the cost of production.
- (c) The fact that potash manures are not so far required under the system of farming adopted where the straw is left on the land also lessens the annual manure bill.

(d) In the third year, when the land is lying out and being grazed no expense for cultivation and seed has been incurred. The natural herbage, indigenous and introduced, which comes away with the autumn rains without cultivation on the stubbles—grasses, wild oats, wheat shed in harvesting, various trefoils, and herbage self-sown generally—offers valuable grazing and lamb-fattening forage. When a sufficiency of superphosphate—more than the equivalent of what the crop is likely to take out—has been applied to the preceding crop of wheat the land will carry a ewe and lamb to the acre, fatten the lamb and carry the ewe until next season's stubbles are available. Such stubble grazing will return 15s. to £1 per acre in this form, lamb and wool, and the sheep will help to keep the land clean, while the grass and herbage so grazed down assists in the maintenance of humus which more frequent fallowing would tend to exhaust.

On the other hand the practice of fallowing preparatory to wheat universal in the wheat-growing areas may seem to be extravagant use of land, as two acres are monopolised for each acre of wheat grown; but long experience has very forcibly demonstrated the fact that bare fallow, extensive or limited, in inverse proportion to the rainfall, but nevertheless to a considerable extent on every farm, is an indispensable essential to success on the wheat-growing areas. South Australian farmers were the first to demonstrate its value in regions of small rainfall, and were actively practising the operation long years before "dry farming," to which lately much attention world-wide has been given, was even suggested. It is the practice to start fallowing for next year's crop immediately the seeding operations of the year are completed, say, in June, and to continue this work through the winter as weather allows. In the spring the land is cultivated and cleaned, and during the summer it is surface cultivated as often as circumstances may require. Apart from the many advantages accruing from fallowing—conservation of moisture, nitrification, direct gain of nitrogen, and general amelioration of the soil—it is in this State a practice almost worth following for this reason alone, that having the land ready for seeding allows of the wheat being sown in good season, and the gain in wheat started in the first week of May compared with the wheat coming up in the first week in June, other conditions being similar, is 2bush. per acre or more when harvest arrives.

Altogether, if the average yield of wheat be read in apposition to land values, 35s. to £12 per acre in the wheat-growing areas, and to the cheap processes of cultivation and exceptionally cheap methods of harvesting of which the climatic conditions admit, it will be allowed that the position of farming in the State is economically very strong.

The wheats grown are almost wholly of the class soft, white, spring wheat, though efforts are being made to improve their strength from the baker's point of view. For percentages of flour it ranks very high in the world's market, and for the color of the flour it is scarcely surpassed; consequently there is always a keen demand for the wheat in Europe for blending purposes.

The "fair average quality," as fixed by the Chamber of Commerce, varies from year to year from $61\frac{1}{2}$ lbs. per bushel to 63 lbs. per bushel, but samples specially cleaned for agricultural shows range in weight from 64 lbs. to 69 lbs. per bushel.

To make manifest the predominant importance of wheat culture in the rural economy of the State it has only to be instanced that, while the estimated total value of all kind of crops, vines, and fruit produced amounts to £18 per head of the population, the value of the wheat crop for grain and hay is over £13 per head.



Camels Loading, Far North.

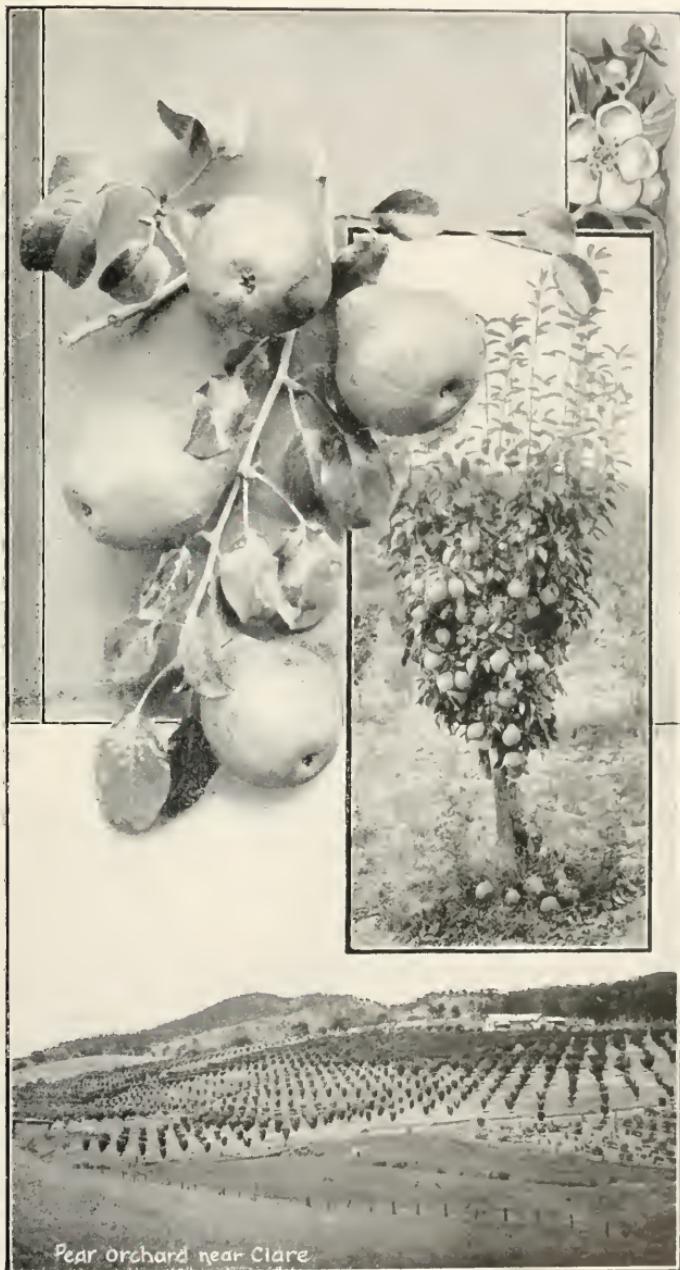
HORTICULTURE.

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THE production of fruit on a commercial scale is carried on over a comparatively widely-scattered area in South Australia. This area may, in respect to this industry, be divided into three climatic and soil zones, each possessing forms of production peculiar to itself. Owing to this range of conditions of soil and climate practically every kind of temperate and sub-tropical fruit is grown to a high state of perfection.

The fruit-growing industry in South Australia (says Mr. Geo. Quinn, the Horticultural Instructor) is carried on throughout a stretch of country about 450 miles long, from Coonawarra in the South-East to Port Augusta in the North. This area may, in respect to this industry, be divided into three zones based on climatic and soil differences, and the items of production are in keeping with the adaptabilities shown by the various kinds of fruit for these zones. Apart from this point, the question of marketing the produce also is a very considerable factor in determining what shall be grown with profit to the producer. These zones may be set out as follows :—

Temperate Zone.—Districts receiving from 21in. to 40in. of rain annually, in which the minimum temperature often falls below freezing point (32° F.) in winter, but seldom exceeds 100° F. in summer. The soils herein vary from light to heavy loams intermixed with disintegrated shales and sandstones, with subsoils of reddish and yellow clays, sandstone rocks, and less often travertine limestone crusts. In a general sense the clay subsoils predominate, and are preferred, whilst the soils and subsoils which are often rich in organic matter are poor in lime. This area embraces nearly the whole of the arable parts of the ranges which rise from the sea near Cape Jervis and extend in a north-easterly direction to Mount Pleasant. It also includes the Barossa Ranges, extending from Williamstown through to Angaston. This approximately represents a tract of land upwards of 100 miles long by 15 to 20 miles wide. To the north-west of this lies the smaller range of hills in which Kapunda is located; again, still farther to the north-west, the elevated country beginning at Riverton and extending a considerable distance beyond Clare. Passing farther in a north-westerly direction the southern spurs of the Flinders Range are met near Crystal Brook, embodying in their folds the Beetaloo and Wirrabara forests and fruit-growing country. The elevated land in the south-eastern portion of the State from Frances along the Victorian border to Cape Northumberland and westward to Kingston and Millicent. Selected parts, chiefly coastal, of Kangaroo Island and of Eyre's Peninsula



Pear orchard near Clare

Pear Orchard, near Clare, 90 miles north of Adelaide.

(county Flinders) are included in this zone. The kinds of fruits principally grown in these parts include the apple, pear, plum, quince, cherry, walnut, strawberry, raspberry, gooseberry, bush currants, and blackberry. In favored positions the grape vine, fig, citrus fruits, peaches, nectarines, and apricots of high quality are also grown. Irrigation is almost unresorted to in fruit production within this zone.

Warmer Temperate Zone.—This embodies a class of country receiving from 18in. to 21in. of rain which nearly all falls during the months of April to October. The temperature of winter occasionally falls below zero, and may sometimes exceed 100° F. in the shade during the months of December, January, and February, accompanied by warm, hot, to dry winds. The soil conditions consist chiefly of light sandy to moderately heavy clay loams with occasional alluvial areas richer in organic matter. The subsoils are mainly retentive of moisture, being red clays or limestone strata. This zone includes the whole of the Adelaide plains; the country around McLaren Vale, Morphett Vale, and Reynella in the south; a large part of the plains immediately south of Gawler; and the open portions of the plains in the Barossa district stretching from Gawler northerly through Tamunda and Nuriootpa. It also includes portions of the flats and foothills along the range of hills around Clare. The fruit products of these portions of the State consist of grapes for wine, table and currant-making purposes, oranges and lemons, peaches, apricots, olives, almonds, figs, nectarines, mulberries the respective importance of each being approximately in the order as given above. Apples, pears, and plums are grown in selected portions of these areas. Irrigation is universally applied to the citrus plantations, but only occasionally used to supplement the rainfall in the production of other choice table fruits. Otherwise, thorough tillage of the soil is relied upon to secure, admit, and retain the natural moisture required for the year's growth.

Hot and Dry Zone.—Country receiving from 8in. to 17in. of rainfall per annum with lower temperatures, often below freezing point, in the cool season (June, July, and August), and frequently above 100° F.—rising to 117° F. in the shade—in the summer, accompanied by hot, drying winds. Soils varying from red, drifting, sandy loam to heavy, dark, stiff loams; and subsoils, gravelly (Flinders Range slopes) to limestone and stiff marly clays along the River Murray, irrigation being absolutely necessary for maintaining the life of the fruit trees. Under this heading is grouped the land situate within irrigable distance of the river along the valley of the Murray above Morgan, and a few small areas on the eastern and western slopes of the Flinders Range, near Orroroo, Quorn, Stirling North, and Baroota respectively. In this country the peach, apricot, citrus tribe (oranges and lemons), fig, olive, and grape vine (including the Muscat, Sultana, and Zante currant varieties) are produced in the greatest

perfection under the influence of irrigation, combined with judicious tillage. Appended to this may be viewed the more limited production in the interior of the date palm of commerce grown by irrigation from artesian bores at Lake Harry and Hergott Springs.



Vineyard and Orchard, Renmark, River Murray.

COMMERCIAL PRODUCTION.

The commercial production of fruit in these various zones may be summarised as follows :—

Varieties and Districts.—At Coonawarra, in the South-East, apples and pears for inter-State and oversea (European) export, prunes for drying, and grapes for wine-making. In the Mount Lofty Ranges, apples and pears for export ; cherries, plums, strawberries, gooseberries, blackberries, raspberries, and to a limited extent apricots and peaches, all for local market in Adelaide, and for preserving factories near by. On the Adelaide Plains, oranges and lemons, almonds, apricots, peaches, figs, pears, grapes for dessert and wine-making, and olives for oil-making. Of the latter product, about 16,000galls. are annually produced. These fruits are practically all utilised for local or inter-State markets. About 12 miles north of Adelaide, at Salisbury, are many fine orangeries, the fruit of which is utilised in a similar manner. In the Barossa, commonly called Angaston, district an orchardist may grow apples, pears for export or canning, apricots, plums, and peaches for canning and drying, currants for drying, and wine grapes, all side by side on the same block. The same may be said of the Clare district, but owing to the absence

of canning factories the fruit suited for that purpose must be dried, and the climatic conditions are slightly moister, so that drying kilns are in use. The more northerly districts of Wirrabara, Beetaloo, &c., grow apples for export and other fruits, which are consumed at the large seaports such as Port Pirie and Wallaroo, also at Broken Hill, a large mining centre. Along the Murray River valley at Renmark and other irrigation settlements the fruit, owing to the distance from the seaboard, is all dried on the spot, with the exception of some pears and Washington Navel oranges which have been successfully exported to Europe.

Factors in Success.—To sum up, the chances for the settler at any of these places may be said to depend upon—(1) The capital at command ; (2) the capacity for hard work ; (3) but by no means least, business management and capability of grasping local conditions and acquiring a knowledge of the business.

Estimated Expenditure and Profit.—To establish a pear or apple orchard on land other than irrigation settlements will take from £15 to £25 per acre, including the purchase of the land, clearing, planting, and fencing, and will cost on an average £2 5s. per acre in upkeep for the first five or six years, during which time scarcely any return will be obtained. From then onwards the return should rise from an average of 1s. to 10s. per tree (a hundred trees are set to the acre). If this is undertaken in the Mount Lofty Ranges, near Adelaide, returns are obtained earlier by growing small fruits—strawberries, &c., and vegetables on the hillsides and swamps respectively. These, however, call for much hard work and close attention. In the warmer districts where peaches, plums, and apricots, are grown for canning and drying a return is obtained in the third to fifth year, and it increases thence onwards until from £20 to £35 per acre gross may be expected. It has been estimated by practical fruitgrowers that a conservative calculation is £15 per acre net return for apricots, peaches, plums for drying, pear and apple for export and local use ; £25 per acre for citrus (orange chiefly) ; and from £15 to £20 per acre for currant, Sultana, and raisin grapes when in full bearing.

PROSPECTS OF EXPANSION.

With the exceptions supplied in the small bush fruits such as raspberries and bush currants there is room (so far as area of suitable land is concerned) for an immense expansion of the industry of fruit-growing in all branches in South Australia. It is not considered by the fruit expert that the dense populations of the Asiatic countries will, within any appreciable time, become consumers of our temperate fruits at prices sufficiently remunerative to sustain our growers on a civilised basis. Nearer to the wealthier fruit consumers of Great Britain and northern Europe are situated countries wherein certain

fruits, which are not quickly perishable and which we grow well, have been produced equally well for generations and at enormously less cost. The production of the Zante currant in Greece, the prune in France and Bosnia, the almond in Spain, Italy, and other Mediterranean regions, the raisin (lexia and table) in Spain, the lemon in Italy and Sicily, the fig and Sultana in Asia Minor, and the olive over many southern European lands indicates some of the difficulties facing any attempt at stimulating an immediate expansion of the production of those kinds beyond the consuming power of the Commonwealth. The sorts of fruit to which attention should be given must be those which are capable of being placed on European and, possibly, American, Asiatic, and New Zealand markets fresh, by means of insulated storage, when the markets there are comparatively bare—apples, pears, navel oranges, grapes, Japanese plums, cherries. Then there are those which by improved processes in growing, selection, and preparation should be capable of securing remunerative prices in open competition, viz., Sultana, raisin, canned and dried apricots, and canned pears.

Again, there are those kinds or their products which as yet are largely imported from outside countries, notwithstanding the protection of a high Customs tariff, viz., figs (dried), olives (pickled and as oil), and grapes for wine and spirit manufacture.

The following table indicates the growth and fluctuations of the oversea export trade in respect of fresh fruits shipped to England, South Africa, and other countries since 1896:—

Year.	Cases.	Year.	Cases.
1896	647	1905	95,493
1897	11,334	1906	88,885
1898	4,106	1907	36,998
1899	12,264	1908	161,127
1900	20,497	1909	75,760
1901	48,411	1910	118,424
1902	15,750	1911	85,321
1903	56,178	1912	184,826
1904	103,000	1913	41,383

The educational aspect of horticulture is not by any means neglected in South Australia. The work of the horticultural branch consists generally of instruction and the inspection of orchards, fruits, and plants. The range of duties of the Chief Inspector and his staff is, of course, much wider. Lectures are given in the country districts, at the School of Mines, and at the Agricultural College; pruning demonstrations and the planning and supervision of various Government orchards. There is a small garden of four and a half acres on the outskirts of Adelaide proper. This contains a labelled

collection of upwards of 100 varieties of citrus trees and 70 varieties of grape vines, along with a choice selection of practically all the sorts of fruit trees grown in our latitude. These latter are planted and used for demonstration purposes in connection with classes in fruit culture connected with the School of Mines, and are used as a means of instructing individuals who are seeking some special information. Demonstrations of pruning, propagation, and general treatment of fruit trees and vines are given to teachers and scholars from the larger public schools. Almost the whole of the trees in this orchard, which was planted in 1908, have borne fruit, and the citrus trees have yielded useful and interesting results. A portion of the ground is used as a nursery for propagating trees for planting in other Government orchards.



Virgin and Cultivated Land, Mount Lofty Ranges.

At Blackwood there is a fine experiment orchard, containing under test thousands of varieties of fruits collected from all parts of the world. Spraying tests are carried out, and a comprehensive practical inquiry into the cause of bitter pit. The orchard at the Government Experimental Farm, Kybybolite, in the South-East, was established in 1908 to demonstrate the possibilities of apple production for export on the neighboring selections. The trees provide an illustration of how a farmer may succeed in growing a commercial fruit plantation.

At Berri, on the River Murray, a portion of the land set aside for an experiment farm at this new irrigation settlement was allotted for experimental

fruit culture. The effects of varying volumes of water on apricot, peach, and citrus trees will be noted. The effect of under-drainage, manures, and different forms of tillage is also carefully tested on these trees, whilst on grapevines different manures and methods of training are tried. The suitability of different prunes, almonds, and figs, comparative values of different stocks for citrus trees, and new sorts of citrus trees have been chosen as subjects for tests.

Calculating 100 trees per acre as a conservative basis South Australia possesses—

	£
Almonds, 2,625 acres yielding 282 tons of nuts worth at 6d. lb.	15,766
Apricots, 2,422 acres, 165,982bush., at 2s. 6d. bush.	20,747
Apples, 9,550 acres, 583,860bush., at 2s. 6d. bush.	72,985
Cherries, 870 acres, 42,607bush. at 4s. bush.	8,521
Pears, 1,450 acres, 81,644bush. at 3s. 4d. bush.	13,607
Plums, 1,573 acres, 106,758bush. at 2s. bush.	10,675
Oranges, 2,246 acres, 220,988bush. at 5s. bush.	55,247
Lemons, 517 acres, 47,176bush. at 2s. bush.	4,717
Peaches and nectarines, 1,872 acres, 80,315bush. at 4s. bush. ...	16,063
Unspecified, 373 acres, 5,533bush. at 2s. bush.	553
Bush and berry, 579 acres, 13,338bush. at 6s. 8d. bush.	4,444
Currants (dried), 2,334 tons 15ewts., at £37 6s. 8d. per ton (calculated at 4d. per lb.)	87,164
Sultanas (dried), 737 tons 3ewts., at £46 13s. 4d. per ton (or 5d. per lb.)	34,400
Gordo and Lexias, 995 tons 8ewts., at £28 per ton (or 3d. per lb.)	27,871
Grand total	<u>£372,764</u>

FREEDOM FROM DISEASE.

South Australian orchards are noted for their cleanliness—the war against pests having been waged persistently along scientific lines. The vineyards also are almost entirely free from disease, and the dreaded phylloxera has never been known to exist. These facts must be taken into consideration, and should certainly carry weight with the horticulturist in seeking a new country. There are still thousands of acres of land, equally as productive as that already planted, which the Government are making available with all possible speed. An orchard or vineyard becomes payable and provides a comfortable competence in five to ten years from planting, according to the sorts grown.

A man of small means who enters into fruit-growing must be prepared to work hard at the commencement, and always intelligently. A first-hand knowledge of his subject will, of course, stand him in good stead. As in all

other rural industries, those possessing money to take up land will find facilities afforded by the Government to continue and increase their operations. An export trade has been built up, and the world's markets are being brought closer to the producer; so that an almost unlimited field is open to the fruitgrower who combines industry with intelligence.

VEGETABLES

May be grown in a very wide range of sorts over an immense area of the State through the cool months of April, May, June, July, August, and September, during which rain falls regularly and the temperatures are very bracing and pleasant. Such short-seasoned kinds as cabbage, cauliflower, brocoli, Brussels sprouts, kale, kohlrabi, turnip, radish, carrot, beetroot, celery, spinach, lettuce, pea, bean, onion, leek, garlic, shallot, parsley, cress, and mustard may be found in almost any kitchen garden where ordinary care and industry is displayed. During the warmer months, covered by October, November, December, January, February, and March, all members of the melon family, including pumpkin, marrow, trombone, cucumber, watermelon, sweet and rock melon, pie or preserving melon, along with tomato, egg fruit, capsicum, rhubarb, potatoes, and asparagus, by the aid of irrigation, become very productive. In the South-Eastern divisions potatoes are grown through the summer without irrigation.

In the deep, peaty soils in the cool gullies of the Mount Lofty Ranges the somewhat unparalleled sight of beds of succulent cabbage, turnip, radish, and lettuce of the finest quality may be seen growing through the summer season alongside of the heat-loving tomato, cucumber, or watermelon.

It is a remarkable fact that throughout the Southern Hemisphere it is only in South Australia that the grower of European race is more than able to hold his own in the production of vegetables in competition with the industrious Chinese.

OLIVE CULTURE.

For the olive tree to flourish it must, like the vine, have favorable climatic conditions, and good, well-drained, and fairly open soils. These exist in South Australia, and Italian experts have affirmed that this is one of the few countries on the earth where the olive can be cultivated to perfection. Since the early days of the State plantations have existed which contain stocks of reputation from all the olive-producing countries of Southern Europe, such as the Bouquettier, Gros Redoneau, Saloneu, Blanquet, and Verdale. As far back as 1851, at the Great Exhibition in London, oil manufactured in South Australia gained "honorable mention on account of its clearness, color, and flavor." Subsequently the local production gained numerous prizes in other parts of

the world, and was awarded a gold medal at the recent Franco-British Exhibition at Shepherd's Bush. The late Sir Samuel Davenport, one of the pioneers of olive-growing in this State, wrote, in the course of an article on the subject—"We have every proof that the vine can flourish over most extensive areas, and that there abounds amongst us alike conditions of soils and climate where we have also proof that the olive tree thrives in a degree which gives to South Australia a great advantage over many other regions where the olive is grown, since by the aid of the elevated temperature of summer, its fruit ripens in good time."

In estimating the value of the olive, its special claim on the score of its great length of life and the cumulative crops it will yield, when carefully cultivated, through many generations of its owners, should not be overlooked. In 1896 the number of trees in bearing in South Australia was 49,609, and these produced 6,512galls. of oil. The area under trees has been steadily increased, and the total production in 1910 was 26,340galls., compared with 16,464galls. for the previous year. From 14 acres in one of the oldest plantations there have been harvested in one year 40 tons of olives, worth £8 per ton. The cost of picking these amounted to £120, leaving a return of £200 from 14 acres. The price for average sample fruit ranges from £8 to £9 per ton, while for the best quality as much as £10 per ton can be obtained. A grower may easily become his own oilmaker, as the appliances required for extracting the product from the berries are of simple construction and inexpensive. Preserving the green berry, though necessitating time and care, is also a very profitable business.

At present the output of oil is not sufficient to enable exportation to take place on any large scale. Practically the whole of the oil is sold within the Commonwealth, and a very substantial price is realised.

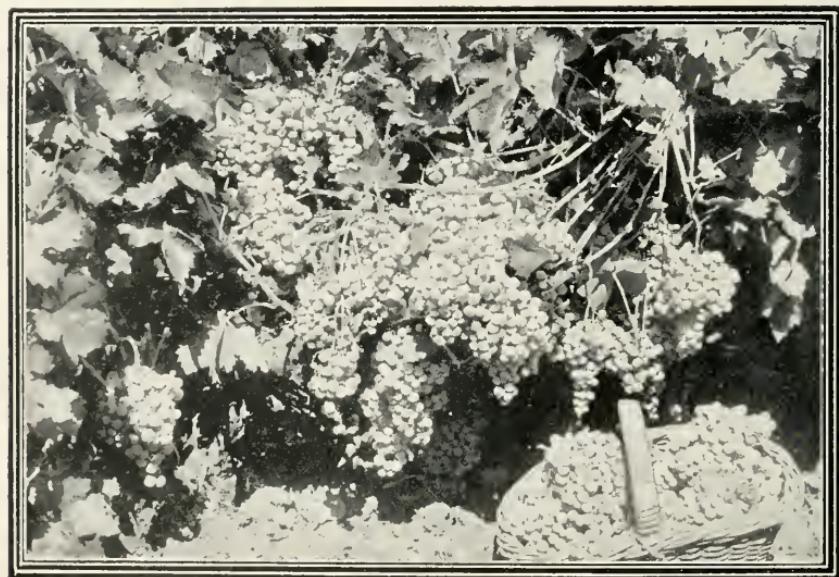
Cultivation was for some time limited to the Adelaide plains and the foot-hills of the Mount Lofty Ranges, but latterly other centres have claimed attention, and plantations have been successfully reared in those districts. Large areas of South Australian soils could be turned to profitable account by this industry, which is one that would prove an excellent investment for capital and labor.

VITICULTURE.

—o—

THE nature of the soil and the climatic conditions obtaining in South Australia are specially suited for the cultivation of the vine. Large areas are devoted to vineyards, and the growth of the wine industry during recent years has been remarkable.

The growers have exhibited much care and judgment in the selection of the best and most suitable varieties of grapes, and have also introduced improved plant and appliances in order to produce a high-quality wine.



30-year old Doradilla Vines, on foothills near Adelaide.

They have also induced French experts to emigrate to South Australia to teach the most modern methods of planting and manufacture; consequently our wines have gained a high reputation throughout the world for their purity and flavor, and the export trade is now considerable. Many visiting experts have recorded their appreciation of the quality of South Australian wines, and have prophesied a great future for the industry. Viscount des Garets, a champagne maker of Epernay, France, visited a number of South Australian cellars in July, 1903, and after leaving the State on his way back to France

he publicly made the following statements :—“ Some of the best wines I have tasted in Australia were those of South Australian production. I am taking several cases of claret, white wines, and brandy to France with me. Before many years the French market will be killed out, and I am quite sure that the export of Australian wines will improve day by day and year by year. Many of the ideas employed by the Australian winemakers came from their own heads. These young countries can teach the older places many things, and I have learnt some ideas which I will put into practice in France. My countrymen do not travel enough. There is always something to be learned in the changed conditions of younger countries. I intend to tell them that when I get home, and persuade them to come and see what Australia has to show. Land, land, land everywhere ; and out here I see the best means, not to become wealthy, but to live very comfortably and make money. It is a great mistake for the old countries not to send more people out to these places. Land is to be had cheaply, and I think the French farmer comes out on top of the list. I will speak about these things when I get home.”

South Australian wines and brandies have gained a large number of prizes at foreign and inter-State exhibitions, and are now in general use in the hospitals of Australia, and many similar institutions in Great Britain.

The Colonial Surgeon in one of his reports stated—“ Colonial wine still continues to be used [in the hospitals], and the experience verifies the remark made in previous reports that, while it costs less, it is superior to the imported article.” The *Lancet*, a well-known medical journal, also bears testimony to the quality of our local production, and in commenting upon a consignment of South Australian wines sent to London, it states—“ Australia at a moderate cost is sending us really good wines of excellent type, and each year sees a marked improvement in the tone and quality of the vintage.”

THE BRANDY INDUSTRY.

With the development of the wine industry there has also been a great increase in the production of brandy, and the superior quality of the South Australian article, manufactured from the pure juice of the grape, has been readily recognised by the medical faculty at home and abroad. About 350,000galls. of spirits are produced annually, and the trade is a rapidly increasing and profitable one.

LAND SUITABLE FOR VINEYARDS.

The State Viticultural Expert, Professor Perkins, affirms that “ the manufacture of a good sound wine capable of holding its own in the world’s market can readily be obtained from a large portion of our agricultural areas.” Land

suitable for vine-growing is obtainable at prices ranging from £10 to £20 per acre. The cost of cultivation is not heavy, and the industry is one which offers a good field for the employment of capital and labor. Already a large amount of capital has been invested, and some of the establishments are of considerable magnitude. The largest and most up-to-date wine-making and distilling establishment in the Southern Hemisphere is situated in this State.

VINEYARDS FREE FROM DISEASE.

It is gratifying to be able to record that the vineyards of South Australia are completely free from serious disease of any kind. The Chief Inspector of Vineyards under the Phylloxera Act, who has several times made a minute inspection of all the vineyards in the State, in his last annual report, among other things, says—"When I undertook these inspections I little thought, and hardly dared to hope, that 10 years after it would be my good fortune to once again report 'total freedom from the dreaded phylloxera, as well as from any other serious disease of the vine.' "



Fruit Exhibit, Adelaide Royal Show.



Remarkable Pines (*pinus insignis*), 24 years old, Wirrabara Forest.

FORESTRY.

DURING recent years great activity has been displayed in forestry. In South Australia many useful varieties of timbers are grown, and the department has adopted vigorous conservation. Like other States of Australia, the earlier colonists paid little heed to the future when they demolished trees in wholesale manner and neglected to replace the deficiency by planting. There is a tremendous leeway to make up, but the department is attacking it in a thoroughly systematic manner. There are now extensive forests of valuable timber, and every year operations are becoming more extensive. Thirty-six years ago the number of trees planted for the 12 months was 100,000. Between 1886 and the early nineties planting was on rather a large scale, comparatively ; but after that time there was a marked decrease, particularly from 1900 to 1904, and then a strong upward movement set in and has been maintained with considerable advantage ever since.

In 1876 the number of trees given to farmers was only 30,000, and in 1911 there were 312,522 distributed, and expenditure has grown from £6,000 to £21,000. In 1910 the financial outlay was doubled, compared with the previous year — £16,000 as against £8,000.

Since 1877 17,002 acres have been enclosed for planting, 9,232,965 trees have been planted, and 8,500,000 trees have been distributed.

Among the varieties of trees planted are yate gum, sugar gum, box gum, blue gum, spotted gum, yellow box, red gum, remarkable pine, large flowered stringybark, narrow-leaved ironbark, blackbutt, leather jacket, forest red gum, Victorian ironbark, black wattle, blackwood, Canary Island pine, maritime pine, and aleppo pine.

The following table will give at a glance the present position :—

Area of forest reserves	161,052 acres
Area enclosed for planting during the year	1,078 acres
Total area enclosed for planting	18,080 acres
Number of trees planted during the year	502,550
Of which are growing	471,330
Stock of trees in nurseries	1,337,281
Revenue for year	£5,608 11s. 5d.
Expenditure ditto	£22,858 8s. 11d.
Value of permanent improvements	£144,998

There were planted in 1913, 502,550 trees, of which 471,330, or 93½ per cent., were living a year later. The area planted during the 12 months to June 30th, 1913, was 924 acres.

The hills and valleys of the Mount Lofty Ranges and elevated tablelands of the north and portions of the southern districts of South Australia are well timbered with various species of eucalypti, acacia, sheaoak, cherry, and honeysuckle. On the plains, where the rainfall is less, the native pine and lesser species of eucalypti are found.

The various species of eucalypti, commonly called gums, which comprise the major portion of the wooded area of the State, are widely distributed. The common names for these trees are red, blue, and sugar gum, stringybark, box, manna, and candlebark gum, and most of these provide first-class timber for all purposes where strength and durability are required — such as sleepers, piles, telegraph poles, fencing posts, well slabs, &c. The majority are also well suited for ornamental purposes and shelter of stock. The inferior varieties, such as mallee, furnish most of the firewood used in South Australia, while others are valuable for the oil and other products which are extracted from them.

Many English trees flourish well in parts of the State. The best return from any exotic is derived from the Remarkable Pine, a native of California. The growth of this tree is phenomenal, and already fruit boxes are being made from pines planted 25 years ago.

The State owns 161,052 acres devoted to the protection and rearing of timber trees. The Woods and Forests Department, which was established in 1875, also rears and distributes to landowners large numbers of trees, which are planted as avenues and shelter for stock. Up to the present about 8,500,000 trees have been distributed.

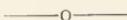
Date palms are successfully grown at Hergott Springs, 400 miles north of Adelaide, and at Lake Harry, 20 miles north-east of Hergott.

FORESTRY AT THE UNIVERSITY OF ADELAIDE.

By the co-operation of the University and the Forest Department, the training of foresters is progressing satisfactorily. One student has qualified for the Bachelor of Science Degree in Forestry, and others will in time follow. A Prospectus of Courses of Training is available from the Forest Department.

Investigations in forestry are also being carried out, which will have useful results.

WATTLE-GROWING



THE growing of wattle (acacia) for the bark, which is now used for tanning leather, is carried on extensively in South Australia. Over a large area the wattle grows naturally, and regular crops of bark are obtained without any outlay in respect to sowing and cultivation.

There is always a demand for good quality bark, and the industry has become of such commercial importance that it has warranted the clearing of large areas of comparatively poor land for the purpose of sowing for wattles. The trees are fit to strip at 5 to 7 years old, according to soil and locality, and after this time will yield from one ton per acre. By stripping the largest trees the thinning gives room for young trees to grow, and that will yield a supply for many years. The market price of the bark is from £5 to £8 per ton.

Thousands of tons of bark are exported annually, and large quantities are used in the local tanneries.



Water-hole on Lindsay Creek, Central Australia.
Red Gum Trees Growing on the Banks (*Eucalyptus rostrata*).

PASTORAL INDUSTRY.

THE expansion of the pastoral industry has had much to do with the general prosperity of South Australia. The pastoralist has been the pioneer settler testing the country and pointing the way for agricultural and closer settlement. The annual returns from pastoral pursuits in South Australia are estimated to have a value of nearly £4,000,000. Even this amount does not represent the full benefits of the industry or the amount of money actually disbursed among the community. The net value of pastoral products exported (oversea)—sheep, cattle, and horses (living), meat (frozen, &c.), skins and hides, tallow, wool, &c., for the year 1912 amounted to £2,685,321 compared with £2,571,660 in 1911.

Of the total area of the State—243,244,800 acres—11,186,540 acres are alienated, either wholly or conditionally, and 111,001,510 acres are leased (excluding 89,077 acres leased for mining purposes). There are 82,463,335 acres of the leased country situated outside and 28,538,175 acres within the counties. Beyond the limits of agricultural settlement 143,042 square miles (91,546,770 acres) are held by Crown lessees as sheep or cattle runs. The rental paid was £25,656, as against £25,681 in the previous year. The following table shows the area of leased land for depasturing purposes:—

Year.	Pastoral Leases.		Annual Leases.		Total Area of Pastoral Land Leased in each Year.	Annual Rent Payable on		Total Annual Rent Payable.
	Number of Leases.	Area Leased. sq. miles	Number of Leases.	Area Leased. sq. miles		Pastoral Leases.	Annual Leases.	
1901 ..	536	107,681	—	—	107,681	35,747	—	35,747
1902 ..	538	113,139	—	—	113,139	32,646	—	32,646
1903 ..	510	114,638	—	—	114,638	30,356	—	30,356
1904 ..	479	113,365	16	4,063	117,428	25,468	455	25,923
1905 ..	468	113,861	32	5,518	119,379	23,214	568	23,782
1906 ..	468	113,112	43	6,709	119,821	23,129	657	23,786
1907 ..	483	116,005	53	8,039	124,044	23,476	769	24,245
1908 ..	485	120,129	64	9,573	129,702	23,635	884	24,519
1909 ..	495	124,828	75	11,169	135,997	23,980	1,004	24,984
1910 ..	523	130,606	82	12,260	142,866	24,595	1,086	25,681
1911 ..	527	130,685	83	12,356	143,041	24,501	1,155	25,656
1912 ..	597	149,199	10	1,358	150,537	26,439	232	26,671



Typical South Australian Stud Merino Ram.

[Chas. P. Scott, Photo.]

The following is a decennial return showing the number of depasturing certificates issued (exclusive of those issued by district councils) :—

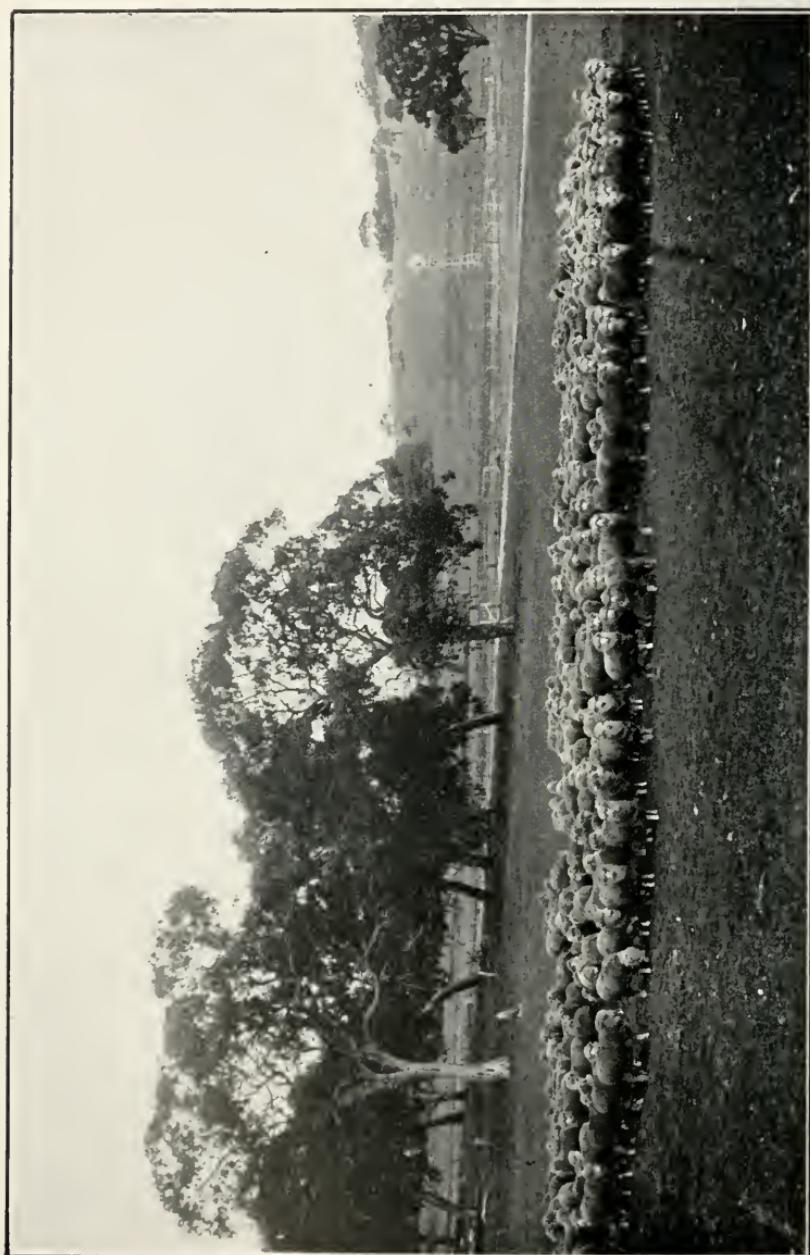
DEPASTURING CERTIFICATES.

Year.	Number Issued.	Number of Head of Great Cattle.	Number of Head of Small Cattle.
1901	242	4,668	47,268
1902	398	6,892	144,485
1903	179	2,981	49,703
1904	196	3,554	9,395
1905	185	3,962	8,846
1906	219	9,739	8,242
1907	195	11,739	15,580
1908	181	10,210	13,888
1909	267	3,046	4,379
1910	208	1,202	5,380
1911	200	658	4,630
1912	195	1,567	10,420

LIVESTOCK IN SOUTH AUSTRALIA.

On December 31st, 1912, it was estimated that the livestock of the State comprised 5,481,489 sheep, 383,418 cattle, 276,539 horses, 11,862 goats, and 69,832 pigs. The following return shows an appreciable annual increase in the flocks, herds, and horses :—

Year.	Horses.	CATTLE.		Sheep.	Goats.	Pigs.
		Milch Cows.	Other.			
1901	165,303	74,995	150,261	5,012,216	8,869	88,886
1902	164,625	75,011	138,332	4,880,540	8,754	82,777
1903	176,648	83,348	161,262	5,298,720	11,650	88,246
1904	183,481	88,156	184,303	5,820,301	13,386	111,497
1905	196,114	93,069	207,652	6,140,600	14,138	117,762
1906	206,633	97,843	227,881	6,624,941	14,317	111,240
1907	208,639	100,743	233,928	6,829,637	13,428	90,741
1908	213,385	106,269	234,107	6,898,451	14,611	78,454
1909	240,405	110,757	233,277	6,432,038	13,349	80,410
1910	249,326	119,628	265,234	6,267,477	14,403	96,386
1911	259,719	121,803	271,763	6,171,907	13,728	93,130
1912	276,539	114,734	268,684	5,481,489	11,862	69,832



Typical South Australian Stud Merino Ewes.

[*Chas. P. Scott, Photo.*

STOCK PER SQUARE MILE IN EACH DIVISION, 1912.

Division of State,	Area in Square Miles.	Horses per Square Mile.	Cattle per Square Mile.	Sheep per Square Mile.	*All kinds in terms of Sheep per Square Mile.
Central	13,891	7.61	6.72	73.53	216.79
Lower North	12,401	4.92	3.45	76.15	159.81
Upper North	14,065	2.17	4.52	50.42	117.83
South-Eastern	15,585	2.32	3.21	81.48	136.80
Western	26,161	.91	.52	20.71	34.99
Outside counties	297,967	.07	.40	3.34	8.02
Total South Australia { 1912 } 380,070	{ .73 .68 }	1.01 1.04	14.42 16.24	31.79 33.43	

* For this purpose each horse or head of cattle equals 10 sheep.

NUMBER OF LIVESTOCK IN DIVISIONS.

The following shows the number of sheep, cattle, and horses in the various divisions of the State in 1911 and 1912:—

			Sheep.	Cattle.	Horses.
Central, 1912	.. .. .. ..	1,021,451	93,327	105,675	
“ 1911	.. .. .. ..	1,190,141	103,846	100,713	
Lower North, 1912	.. .. .. ..	944,326	42,756	60,997	
“ 1911	.. .. .. ..	1,152,848	45,408	57,628	
Upper North, 1912	.. .. .. ..	709,179	63,644	30,467	
“ 1911	.. .. .. ..	797,278	67,945	27,888	
South-Eastern, 1912	.. .. .. ..	1,269,823	50,005	36,209	
“ 1911	.. .. .. ..	1,374,627	54,581	32,772	
Western, 1912	.. .. .. ..	541,865	13,545	23,818	
“ 1911	.. .. .. ..	575,486	13,791	22,743	
Outside dist's, 1912	.. .. .. ..	994,845	120,141	19,373	
“ 1911	.. .. .. ..	1,081,527	107,995	17,975	

INFLUENCE OF CLIMATE.

Stall-feeding of stock is unknown in South Australia, owing to the mildness of the weather. Climate is an important factor in the development of the pastoral business. Sheep, cattle, and horses thrive on natural herbage out in the open throughout the year. The fact that housing and artificial feeding are not necessary enables a big saving to be made in the raising of stock and production of wool, and partly explains the rapid expansion of the industry in Australia. Those of the early settlers who had been accustomed to stock were quick to recognise that the country and climate were eminently adapted

to the breeding of sheep and cattle. Within two years of the proclamation cattle were brought overland from New South Wales, and the pioneer pastoralists went farther and farther afield, increasing their flocks and herds from year to year. A history of the pastoral industry would embrace the commercial, agricultural, and social record of the State. The pastoralist "blazed the trail," and it was upon him that the early colonists depended for food supplies and the inauguration of an export trade which ever since has been the base of the State's prosperity.



Shipping Wool, Port Adelaide.

FLOCKS AND FLEECES.

The first vessels which left London for South Australia carried Leicester and Southdown sheep. Purchases were made *en route* at Capetown, where sheep were selling at the time at 5s. each. The South Australian Company purchased Merinos from Saxony and Tasmania, and importations of Merinos were made at an early date from New South Wales. Within two years of the proclamation of the province the flocks numbered 28,000. Importation and natural increase made the colonizing company the owner of 20,000 sheep by the end of 1841, and several private individuals' herd flocks up to 10,000 each. From that time onwards there was an annual addition to the flocks, and the value of the wool exported steadily increased.

In 1837 four bales of wool were shipped to London, this "parcel" constituting the first export of a South Australian clip! Total shipments of wool

to the end of 1912 aggregated over 2,653,000,000 lbs., and a value exceeding £76,000,000! The growth of this branch of the pastoral industry since 1850 is shown in the following table:—

	Year.	Sheep.	Lbs.	£
1850	1,000,000	3,266,017	131,731
1860	2,824,811	11,731,371	573,368
1865	3,779,308	16,269,890	821,482
1870	4,460,655	25,905,728	902,753
1875	6,179,395	39,723,249	1,833,519
1880	6,454,579	43,390,566	1,716,171
1890	7,004,642	39,281,447	1,353,762
1891	7,646,239	51,561,485	1,618,487
1895	7,250,000	54,550,423	1,438,776
1900	5,235,220	33,277,660	1,003,391
1901	5,012,216	37,530,720	1,029,063
1902	4,880,540	34,168,346	1,061,809
1903	5,298,720	39,281,604	1,326,236
1904	5,820,301	34,299,232	1,506,236
1905	6,277,812	35,412,796	1,356,595
1906	6,624,911	41,771,682	1,561,564
1907	6,829,637	50,639,368	2,100,067
1908	6,898,451	46,333,486	1,629,662
1909	6,432,038	46,533,849	1,815,653
1910	6,267,477	53,785,018	2,069,330
1911	6,171,907	*57,948,565	*1,933,379
1912	5,481,489	*53,387,053	*2,032,383

* Oversea exports only.

The following table shows the number of sheep, the number of pounds of wool exported, the average per sheep, the declared value and rate per pound at port of shipment, and also the London price of average Adelaide greasy wool for the last 10 years. The rainfall for each season is also given:—

Year.	Rainfall (Ade- laide).	Sheep at End of Y. ar.	S.A. Wool Exported (in Grease and Washed).		Valued Declared at Port.		London Sales' Prices (Average Greasy).
			Total.	Per Sheep.	Total.	Per Pound.	
1900	Inches. 21.68	Numbers. 5,235,220	Lbs. 33,277,660	Lbs. 6.36	£ 1,003,391	d. 7.24	7.50
1901	18.01	5,012,216	37,530,720	7.49	1,029,063	6.58	7.00
1902	16.02	4,880,540	34,168,346	7.00	1,061,899	7.46	8.50
1903	25.47	5,298,720	39,281,604	7.41	1,326,236	8.10	8.00
1904	20.31	5,820,301	37,530,200	6.45	1,367,473	8.74	8.50
1905	22.28	6,277,812	40,784,613	6.40	1,491,943	8.78	8.75
1906	26.51	6,624,941	41,771,682	6.31	1,561,564	8.97	9.08
1907	17.78	6,829,637	50,639,368	7.41	2,100,067	9.95	9.40
1908	24.56	6,898,451	46,333,258	6.72	1,629,662	8.44	8.00
1909	27.69	6,432,038	46,533,849	7.23	1,815,653	9.36	9.21
1910*	24.61	6,267,477	53,654,831	8.56	1,943,455	8.93	8.58
1911*	15.99	6,171,907	57,948,565	9.39	1,933,379	8.01	8.75
1912*	19.57	5,481,489	53,387,053	9.74	2,032,383	9.14	9.25

* Oversea exports only.

“ LOCAL ” WOOL SALES.

At one time the bulk of South Australian grown wool was shipped by the growers to London. About 1860 foreign buyers began making direct purchase in Australia, but it was not until the eighties that Australian wool auctions assumed any importance. The development of “ local sales ” in South Australia is indicated in the following :—

	Season.	Total Exports.	Local Sales.	Per cent. Local Sales to Exports.
1894-5	..	Bales, 173,189	Bales, 64,056	Bales, 37
1895-6	..	179,576	80,234	41
1896-7	..	153,751	63,804	41
1897-8	..	116,592	51,287	43
1898-9	..	113,056	61,122	54
1899-1900	..	119,766	70,682	58
1900-1	..	115,774	42,637	37
1901-2	..	111,676	65,239	58
1902-3	..	96,524	61,215	63
1903-4	..	98,484	58,509	59
1904-5	..	108,838	71,018	65
1905-6	..	124,472	85,691	68
1906-7	..	146,431	105,925	72
1907-8	..	163,892	119,713	73
1908-9	..	165,513	134,701	85
1909-10	..	160,573	138,757	86
1910-11	..	174,639	145,076	83
1911-12	..	176,985	147,375	83
1912-13	..	164,259	147,983	89

CHARACTERISTICS OF SOUTH AUSTRALIAN MERINOS.

The Merino flocks of the State had an excellent foundation in the parent flocks selected in Saxony and from the Macarthur pioneer stud, New South Wales; and it has ever been the ambition of leading breeders to improve the constitution and frame of the animal and increase the weight and value of its fleece. As a result a special type of Merino has been produced in South Australia, and heavy drafts are annually made upon leading studs to fill orders from all parts of Australia, New Zealand, and South Africa. The South Australian Merino, which is so much in favor in the interior of the continent and the countries mentioned, is a vigorous animal of large symmetrical frame, robust constitution, carrying a heavy fleece of wool of long staple, showing character, and possessing beautiful lustre and softness. Artificial feeding is never on any consideration practised by the leading stud Merino breeders of the State. The relentless law of the survival of the fittest is allowed full scope. There are a number of high-class Merino stud flocks in the State.



Wool Store, Port Adelaide.

Various mutton breeds, such as Shropshire, Lincoln, Leicester, Dorset-Horn, and Romney Marsh have been introduced, and they have had a marked influence in improving the quality of lambs frozen and exported to the United Kingdom. Angora Goats do remarkably well in various parts of the State.

CATTLE.

It was on April 3rd, 1838, that the first herd of cattle arrived in Adelaide overland from Sydney. It comprised 335 head, and was in charge of the owners, Mr. Joseph Hawdon and Mr. C. Bonney, who during the journey of 10 weeks lost only four bullocks. To celebrate this important event 90 gentlemen sat down at a public dinner, and an ox chosen from the herd was roasted whole. Mr. Eyre, who subsequently won renown for his exploring exploits, was the second overlander with cattle, and Captain Sturt was in charge of the third party. From that time onwards cattle-raising became a profitable industry, and the herds gradually increased, as may be gathered from the following :—

Year.	No. of Cattle			Year.	No. of Cattle.			
1838	2,500	1890	..	..	359,000
1840	15,000	1900	..	..	214,000
1850	60,000	1910	..	..	384,862
1860	78,000	1911	..	..	393,566
1870	136,000	1912	..	..	383,418
1880	307,000				.

The percentage of cattle in South Australia to the total for the Commonwealth has risen from 2·65 in 1901 to 3·29 in 1912.

From time to time importations have been made of high-class cattle. Considerable attention has been devoted by several breeders to the production of high-class Ayrshires, milking strains of Shorthorn-Jerseys, while splendid specimens of the noted milkers, Holstein-Friesians, have also been imported. The Shorthorn and Hereford breeds are the mainstay of the cattle industry, and some splendid specimens of these are to be found throughout South Australia.

HORSES.

Horse-breeding received early attention at the hands of pioneer settlers, and within a few years of the proclamation leading colonists began importing high class stallions and mares, mostly on the light side. An attempt was made in the forties to induce the legislature to grant a bonus to the importer



"Musterers," Far Northern Station.

[*Chas. P. Scott, Photo.*]

of the best animals in a given period suitable for "cart and farm work." High-class stock was imported by leading breeders at various periods. South Australia is the natural home of the horse, climate and herbage being unequalled in aiding the production of a hardy animal. The horses bred in the far northern parts of this State are wonderfully stanch and are good "doers." They are capable of making long journeys without shoes on a minimum supply of water and feed. Astonishing feats of endurance are recorded in favor of the South Australian bred horse accustomed to the stony saltbush plains of some of the north country. Stuart, the explorer, on his great trip across the continent used northern-bred horses, and they carried the party long stages day after day. Only one animal was lost on this arduous journey.

The following shows the number of horses in the State during the years given :—

Year.	Horses.	Year.	Horses.	Year.	Horses.
1838	180	1870	83,744	1910	249,326
1840	1,060	1880	155,915	1911	259,719
1850	6,488	1890	187,686	1912	276,539
1860	49,399	1900	166,790		

The percentage of horses in South Australia to the total for the Commonwealth has risen from 10·20 in 1901 to 11·53 in 1912.

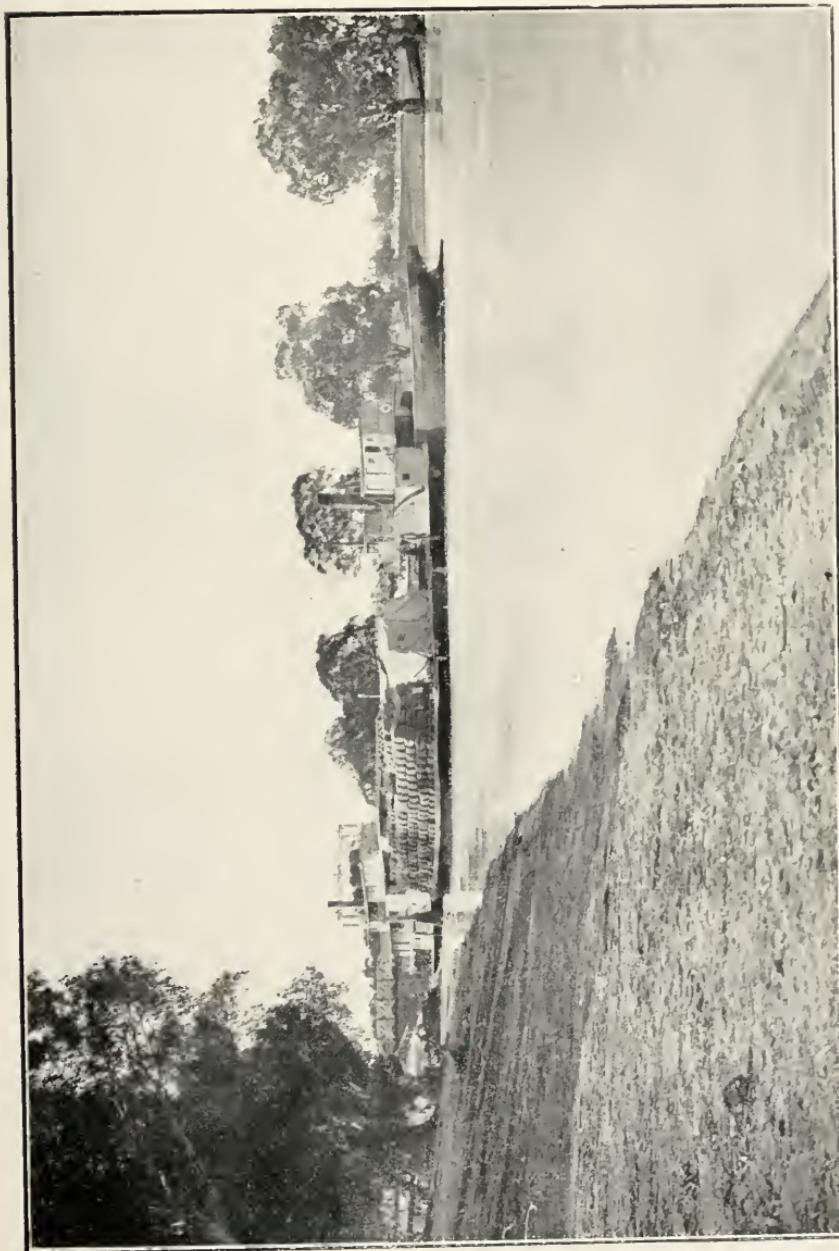
For a time little attention was paid to horse-breeding, owing to the low prices ruling ; but with the increasing demands from South Africa and for the Indian remount service the industry has revived. During recent years a great improvement has taken place in quality, and further efforts are being made to produce the right stamp of animals. Frequent drafts are sent to India, Java, and South Africa.

The Australian turf owes much to the enterprise of early South Australians. The high standard in the thoroughbred classes up to the eighties was due largely to the influence of South Australian horses.

FROZEN MEAT TRADE.

The growth of the frozen meat trade has largely contributed to the general prosperity of the pastoral and agricultural industries of the State. Freezing works have taken the place of "boiling-down" establishments, and the change has meant a great deal to growers.

It is estimated that for the year 1912 slaughterings for home consumption and export represented 1,329,763 sheep and lambs, 112,109 cattle, and 84,792 pigs.



Transporting Wool down the River Murray to Seaboard.

[R. W. Martin, Photo.]

The following table shows the total exports of frozen mutton and lambs since the inauguration of the export business in 1895-6 :—

Year.	Lambs.	Hoggets.	Mutton.	Season's Total.
1895-6	1,751	—	1,097	2,848
1896-7	10,606	—	675	11,281
1897-8	3,534	—	463	3,997
1898-9	38,620	—	2,052	40,672
1899-1900	89,980	—	1,334	91,314
1900-1	94,597	—	7,122	101,719
1901-2	92,574	—	—	92,574
1902-3	116,843	—	38,120	154,963
1903-4	156,366	—	20,911	177,277
1904-5	193,680	—	2,565	196,245
1905-6	251,569	—	—	251,569
1906-7	227,383	—	3,047	230,430
1907-8	271,629	—	4,490	276,119
1908-9	267,037	6,377	67,622	341,036
1909-10	154,399	504	99,596	254,499
1910-11	195,436	2,981	43,116	241,533
1911-12	132,062	638	72,458	205,158
1912-13	108,904	10,148	85,608	204,660
Totals	2,406,970	20,648	450,276	2,877,894

Government works are established at Port Adelaide, where all the freezing for export is done. This dépôt has a capacity for treating 8,000 sheep per day.

The value of the exports of South Australian pastoral products to countries beyond the Commonwealth States—animals living, meat (frozen, &c.), skin and hides, tallow, wool, &c.—for the last five years was:—1908, £1,973,977; 1909, £2,401,304; 1910, £2,720,783; 1911, £2,571,660, and 1912, £2,685,321. The chief item was wool.



South Australian Horses.

[Chas. P. Scott, Photo.]

FISHERIES.

South Australia has a coast line of 2,686 miles, and with its well-sheltered bays, islands, and coves is naturally the home of fish and the paradise of both fisherman and angler, as nearly all fishing is carried out under the most favorable conditions, shelter from hard gales for the boats being plentiful.

The principal fishing grounds are in the vicinity of Kangaroo Island, Spencer's Gulf, St. Vincent's Gulf, and the West and South-East Coasts, where hundreds of fishermen ply their calling successfully, using a fleet of boats that is said to be the finest in Australia. They are principally cutter-rigged and motor-propelled well boats, which carry their freights to the various ports in a live state for shipment by railway to the markets.

The facilities now offered for transit by refrigerator steamers running to the fishing ports of the West Coast will make it possible for a greater number of fishermen to exploit these grounds.

Crayfishing is an important branch of the industry. During the last two years the number of men employed has been doubled, but even now the supply is not equal to the demand.

The principal sea fishes caught in the waters of our State are schnapper, whiting, butterfish, garfish, mullet, snook, salmon, flounder, bream, and barracouta, while among the crustacea, crayfish and the blue swimming crab are the most important.

The most valuable of our inland fisheries is the River Murray, which, with its lakes and backwaters, provides very large quantities of Murray cod, mulloway, perch, bream, and Murray lobster, for which there is a good demand. Over 323 tons were carried by rail to markets for the year ending June 30th, 1913, and large quantities were sold at the various towns on the river. The market price for cod reached 1s. 10d. per pound in October, 1912.

Fishing by anglers can be had on many grounds along the seacoast, and frequently large hauls are taken by yachtsmen in the gulfs. Good catches are also made in streams where fish have been placed by the department, and from the various jetties, the waters around which are protected by the Act against the use of any description of net.

The Federal investigation ship *Endeavor* has trawled, for scientific investigation, on our coast, and the Federal Director of Fisheries (Mr. H. C. Dannevig)

is confident that he has discovered a good fishing ground in the great Australian Bight. Should this discovery prove of commercial value there is no doubt that trawling will be carried on for the Adelaide market.

Should the waters and nature of the sea-bottom prove suitable, varieties of edible fish from the northern seas may be introduced to our State.

The Fisheries Acts of 1904 and 1909, and the regulations thereunder, express the fishing laws of the State. These provide for the supervision of the fisheries and the fostering of the industry. Fishermen who ply their calling must be either natural born or naturalised British subjects, and be licensed—the fee, 10s. per annum.

The boats used in the industry are registered with a view to protecting the indiscriminate taking of fish. Provision is made for the establishment of natural hatcheries for protection during periods of propagation, for restricting the use of harmful devices used for taking fish, and in other ways for the benefit of the industry.

A new feature of the Acts is the provision made for paying out of licence fees for the destruction of fish enemies, and under this the department has paid over £4,602 for the heads of cormorants and turtles. It is believed that each cormorant devours 5lbs. of fish daily, and the destructiveness of turtles, in regard to fish spawn, is well known. By the removal of these enemies fish life has been preserved to a great extent.

Close seasons have been proclaimed, during which it is illegal to use any description of net, while other places have been set aside as natural hatcheries.

At the request of the Government of South Australia the New South Wales Fisheries Department has closed Lake Victoria, situated a short distance outside the border of this State, which is one of the principal natural hatcheries and nursery for the Murray cod, and the whole Murray River from there to Blanchetown is closed during the months of October and November.

During the year 1912-13 there were licensed fishermen using over 900 registered fishing boats. The amount of fish carried over the South Australian Railways during the same period was 1,440 tons, with a freight value of £4,033 15s. 11d.

MANUFACTURES.

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IN a country of such vast expanse, and with the wonderfully fertile soil which South Australia possesses, it must necessarily follow that primary production is, and will continue for an indefinite period to be, the most important item in the programme of the State's operations. Nevertheless, there are established numerous secondary industries which have made wonderful strides during the past decade ; and in many articles of household use the State is practically self-supporting. Machinery for the agriculturist takes a prominent place among local manufactures, and throughout the State there are workshops for turning out every implement from the plough to the modern harvester. In this connection South Australia has to her credit the invention of implements which have considerably cheapened the cost of farming, and brought under profitable cultivation large areas which would not otherwise have been available. In the large engineering manufactories immense pieces of mining and other machinery are turned out, which would do credit to many an old-world establishment. The Government possesses extensive workshops, where the construction of locomotives and rolling-stock for the railways is undertaken ; and materials for waterworks, sewers, and other services are also manufactured in the State, both departmentally and by private enterprise.

The mining industry is responsible for the employment of a large number of artisans. At Port Pirie, a shipping centre north of Adelaide, the ore from the Broken Hill mines is smelted in what is admittedly the largest silver-lead smelting works extant ; and nearer Adelaide (at Wallaroo) are the copper smelting works, which turn South Australia's chief metal product to commercial account.

Generally speaking the factories are up to date in plant and arrangement, and compare favorably in so far as the comfort of the employés is concerned with any part of the world.

That many important manufacturing industries have gained a firm footing in this State is emphasized by the following official statistics :—The total number of factories in South Australia at the end of 1912 was 1,341. These employed 28,500 persons, and the salaries and wages paid during the year, exclusive of the amounts drawn from the business by working proprietors, totalled £2,869,965. The approximate amount invested in land, buildings, plant, and machinery was £5,878,374. The value of the raw material treated

or worked up is set down at over £8,199,110, and the wholesale selling value on the premises of new work turned out and the charges to customers for repairing work total some £13,450,000, which shows that the net value of the secondary industries to the State is about £5,250,000 annually.

CHAMBER OF MANUFACTURES.

The South Australian Chamber of Manufactures is an active body, composed of representatives of the leading manufacturing firms. It is the oldest organisation of its kind in Australia, and has justified its existence a thousand-fold. The chief objects of the Chamber are—“To promote the development of South Australian manufactures and products, and in furtherance of such objects (a) to hold meetings at which lectures may be delivered, papers read and discussed, and, where deemed of sufficient value, published for distribution amongst members ; (b) to hold exhibitions for the display of manufactures and products, and such of the arts as may be deemed advisable ; (c) to offer premiums or prizes for new inventions, and to encourage skill in connection with work appertaining to the objects of the Chamber ; (d) to establish a library and industrial museum, accessible to the members of the Chamber ; (e) to closely watch all legislation and decisions of the courts on matters affecting the objects of the Chamber, and to take such action as may be deemed necessary.”

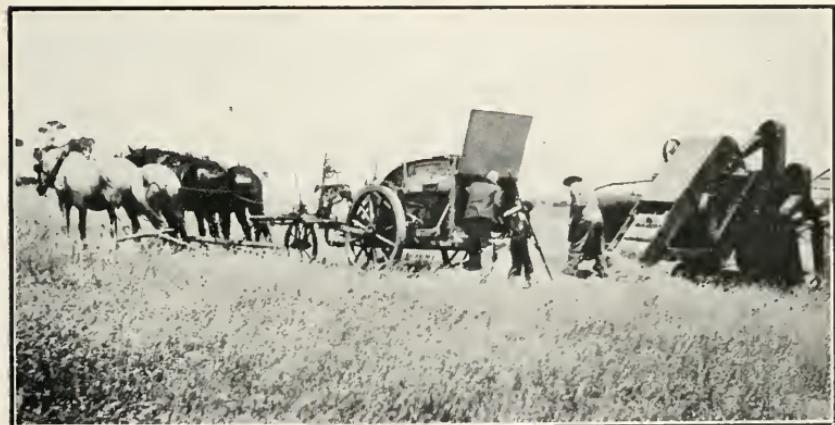
The Chamber is the owner of a fine property in Pirie Street, which is known as the Chamber of Manufactures.



Silver-Lead Smelting Works, Port Pirie.

ALL-AUSTRALIAN EXHIBITION.

In carrying out its objects the Chamber has engaged in a number of undertakings to bring the productions of the State under public notice. The most important of these is without doubt its periodical exhibition of manufactures, products, arts, and industries, which is held in Adelaide every five years. The next of these exhibitions will take place in 1915 for two months, opening on March 26th of that year. The exhibitions, which are confined strictly to things Australian, include sections for manufacturers' trade exhibits, fine and applied arts and crafts of every description.



From Stripper to Winnower.

IRRIGATION AND RECLAMATION.

THE birth of practical irrigation in South Australia dates from the advent of Messrs. Chaffey Bros., at Renmark, in 1887. Previously a number of our progressive settlers had practised the aid of artificial watering, but not on an extensive or properly established system.

The pioneer firm of irrigators were practical Americans, hailing originally from Canada, afterwards migrating to California, where they established successfully two irrigation settlements in Etiwanda and Ontario. These eminent irrigationists were sanguine as to the great future possibilities to be derived from the artificial application of water as the prime factor in successful cultivation, and the closer settlement movement of our semi-arid country along the banks of the Murray wherever the water supply was sufficient to meet such requirements.

As in every great movement, initial mistakes were made, but the optimism of these promoters of irrigation never flagged, despite the army of pessimists they had to contend with. The results of to-day amply justify that optimistic spirit, and the State is now awakening to the true value of its irrigation inheritance.

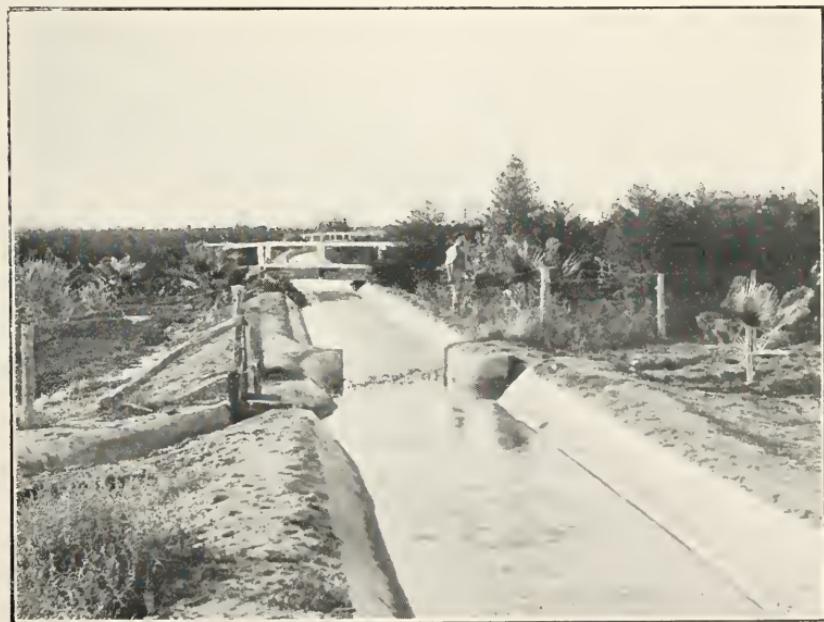
Ten years ago national irrigation in the arid and semi-arid States of America was a dream of the distant future—to-day it is a pronounced fact. Country which was considered as desert, as hopeless as the Sahara in one sense of the term, with the successful and economical application of water, now supports tens of thousands of prosperous settlers.

South Australia does not aspire to extensive irrigation areas, but there is room for many lesser schemes apart from those along the Murray Valley. Mr. S. McIntosh, Director of Irrigation, writes—

Scattered over our dry and semi-arid districts, wherever natural waters are available, as at Pekina, we possess quite a number of areas ranging from a few hundreds up to several thousand acres in extent, which could be profitably irrigated by the gravitation system from headworks. Artesian water supplies also promise a large share in the prosperous occupation of considerable areas of at present practically worthless country, wherever the quality of the water is suitable. At present very valuable and interesting experiments are being carried out by the New South Wales authorities and others in the neutralising of the injurious alkalis contained in some of their artesian flows; and we are sanguine that practical scientific research work in this direction will, at a no great distant period of time, enable us to profitably and successfully use water which at present contains such an excess quantity of certain solids as to render it positively dangerous to plant life. Still we have many instances of artesian water being used with success in the growth of fruit

trees, vines, date palms, and fodders. Fruit from the date plantations at Hergott Springs is, during the season, on sale, and its quality compares more than favorably with the very best imported article, while the price is within the reach of all. There is room for very considerable areas of this valuable product, and there is no doubt as to the market in this direction for years to come ; in fact, as population increases, so will the demand for this (when grown in South Australia) clean, wholesome, and popular fruit.

Lucerne and fodder grasses can be produced in abundance on our dry lands with the judicious use of water, and country at present carrying not more than a sheep to five or 10 acres rendered capable of successfully grazing from 15 to 20 sheep to the acre. The value of such irrigated pastures is the better realised and appreciated during the periods of drought, when thousands of stock which would, under natural conditions, perish, can then either be carried over the lean years or fattened and marketed with a considerable margin of profit to the owner.



Irrigation Channel, Renmark.

RESULTS OF IRRIGATION.

Renmark, which came into existence in 1887, has a population of over 2,500. It is situated on the Murray River, 355 miles from the mouth, by river, 156 miles above Morgan, 44 miles below the Victorian border, and 161 miles below the junction of the Darling River with the Murray at Wentworth.

By land, Renmark is 75 miles from Morgan, and 179 miles by rail and road from Adelaide. In November, 1913, the construction of a railway on the eastern side of the River, with its terminus about two miles below Renmark, was completed. Renmark is an irrigation colony, and was founded under the Chaffey Bros. Irrigation Works Act of 1887. Since 1897 the irrigation works have been administered by the Renmark Irrigation Trust No 1, a body elected periodically from among themselves by the ratepayers of the settlement. The original grant of land to Chaffey Bros. comprised 250,000 acres, and extended to the New South Wales border. In 1902 the area actually controlled by the Irrigation Trust was reduced to 13,348 acres; but in addition to this 15,652 acres have been dedicated to the Trust for commonage purposes. Renmark, now recognised, together with the sister settlement of Mildura, as one of the most successful irrigation settlements in the world, is the outcome of the enterprise and energy of Messrs. Chaffey Bros. The early settlers paid from £20 to £25 an acre for uncleared land with attached water right, believing that the efficiency of the pumping service was guaranteed by the Government. The failure of the promoters left the works in a very unsatisfactory state. In 1896 and 1900 loans of £3,000 and £16,000, respectively, were granted by the Government to enable the Trust to put the machinery and channels into a state of efficiency. This money is now being paid in half-yearly instalments of principal and interest.

The following table will serve to illustrate the gradual progress of the settlement to its present satisfactory condition :—

Year.				Acres Irrigated.	Estimated Value Produce. £
		
1896	..	..	..	2,700	6,878
1897	..	..	..	2,800	16,869
1898	..	..	..	3,200	11,968
1899	..	..	..	3,200	18,167
1900	..	..	..	3,200	22,086
1901	..	..	..	3,200	28,167
1902	..	..	..	3,250	35,000
1903	..	..	..	3,300	39,250
1904	..	..	..	3,500	40,250
1905	..	..	..	3,700	41,550
1906	..	..	..	3,838	52,000
1907	..	..	..	3,860	85,000
1908	..	..	..	4,182	60,000
1909	..	..	..	4,900	85,000
1910	..	..	..	4,993	100,000
1911	..	..	..	5,157	10,000
1912	..	..	..	5,173	130,000
1913	..	..	..	5,237	135,000

The following are the figures for the fruits produced in Renmark during the last two seasons :—

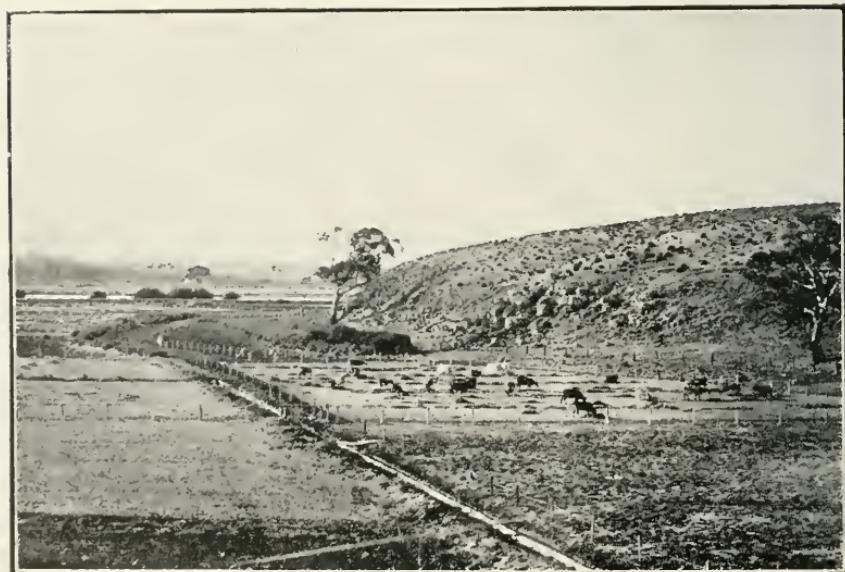
Varieties.	1912.	1913.	Area in full and partial bearing, 1913.
	In tons.	In tons	In acres.
Apricots	234	146	294 $\frac{3}{4}$
Peaches	47	59	159 $\frac{3}{4}$
Pears	8 $\frac{1}{2}$	23	25 $\frac{1}{2}$
Currants	633	663	651 $\frac{1}{4}$
Sultanas	571	787	915 $\frac{3}{4}$
Lexias	574	416	590 $\frac{1}{2}$
Layers	9 $\frac{1}{2}$	3	—
Distillery Grapes	557	1,350 (approx.)	—
Total Dried (Weight) ..	2,263	2,617	..
Cases.			
Oranges	25,000	..	159 $\frac{1}{2}$

Renmark has now 5,237 acres of irrigated land, which previous to 1887 would not carry more than 2,000 sheep during the most favorable season. Water is here pumped from the river at a cost of 1d. per 19,000galls., and is delivered on the irrigation level through a second pump at a cost not exceeding a penny for 9,000galls. The annual average irrigation requirements along the river settlements is from 20 acre inches to 30 acre inches per acre. The cost of pumping the necessary water for irrigation purposes on the majority of the settlements with the higher irrigation lands averages from 30s. to 40s. per acre per annum.

Private irrigation settlements along the river include Murtho, with a pumping plant capable of delivering 48,000galls. per hour. Mr. W. Lewis, of Gurra Gurra, who, with his family, is making a splendid living from less than 20 acres of irrigated land, which, under its natural condition would have starved a sheep, provides a splendid ocular demonstration as to the true value of irrigation when correctly practised. The Pyap Proprietary Co. holds about a thousand acres of soil well adapted for artificial watering, and are already irrigating 200 acres of orchards, vineyards, and fodders. The highest level irrigated is 120ft., and the capacity of the plant 175,000galls. per hour. Moorook, which was one of the original settlements, is most successful in its production of dried fruits, apricots in particular. An extended irrigation scheme is proposed, which will cover 1,200 acres. Holder Estate, another ex village settlement, contains 6,900 acres, about 250 of which are being successfully irrigated. Following Waikerie and Rameo down stream, we next visit " Murray View," Messrs. Metters' property, of 2,000 acres, where several hundred acres are under irrigation. The supply is pumped with three gas producer plants, giving a joint capacity of 360,000galls. per hour. Mr. H. H. Dutton's estate, near Morgan, contains 19,000 acres, of which at least 550 can be profitably irrigated. At present a considerable area is supplied with water, through the medium of a gas producer plant, with a delivery of

180,000galls. per hour. The Nor'-West Bend Estate contains 2,422 acres, of which about 400 are under the water command ; a further 500 acres could be irrigated with profit. Pumping plants with a capacity of 407,500galls. have been erected. Brenda Park, the property of Mr. S. Willcox, contains 10,438 acres, of which 700 are reclaimed from river floods and irrigated. The full pumping plant has a capacity of 520,000galls. per hour. Both Brenda and Nor'-West Bend consist partly of areas reclaimed against river floods, and at certain seasons of the year can be irrigated from sluice gates by gravitation from the river. A number of other irrigation farms and plots are to be found along the river banks throughout its length.

With judicious cultivation and irrigation, crops of two tons of currants and raisins per acre are no exception. Lucerne crops yield up to 12 tons of dry or 36 tons of green fodder per acre, while with systematic grazing from 10 to 30 sheep per acre can be carried at a profit.



Reclaimed Swamp Land, Murray Bridge.

What promises to be the most successful class of closer settlement in the State, is on the reclaimed swamp and overflow lands of the lower Murray. The valley of the River Murray contains approximately 250,000 acres of land of varying quality, all rich in organic matter, and the bulk of which may be utilised with a very decided margin of profit. The upper lands can in many places be either wholly or partially reclaimed, and when the river water falls below the level to permit of gravitation irrigation, owing to the low lift, effective and economical pumping plants can supply the balance of water

required for intense culture at a minimum cost. Firewood is to be had in abundance, and charcoal as a motive power can be produced at a low figure. The soils on the lower reaches of the river, of which there is a very considerable area that can be reclaimed, have proved both from analysis and actual results to be some of the richest in the known world. They are composed of layer upon layer of rich river silt, intermixed with immense bodies of decomposed vegetable (aquatic and semi-aquatic) growth, added to the droppings of fish, water birds, &c., and deposits of decayed animal matter, to a total depth in many places in the lower Murray of over 40ft. There can be no possible shadow of doubt, but where such lands as described are properly reclaimed against the inroads of flood waters, and effectively drained, they will become some of the most productive in Australia, and will hold their own with the best in the older countries of the world.

The overflow swamps of the Murray, from its discharge into Lake Alexandrina up stream to Mannum, contains approximately 25,000 acres of the richest organic soils in Australia, proved by analyses, which gave the phenomenal result of 41,275lbs. nitrogen, 5,200lbs. phosphoric acid, and 39,325lbs. potash to the acre foot (dried at 105 per cent. c.). Practical results include a crop of 30 tons of onions to the acre, grown by Messrs. H. W. Morphett & Co., of Woods Point ; $3\frac{1}{2}$ tons of lucerne hay per acre from at least two local farms from one cut. The annual average lucerne hay crop is from 7 to 10 tons ; the plant continues growing during winter ; in addition to wonderful yields of malting barley, oats, mangolds, pumpkins, beans, &c.

The following list gives the respective areas reclaimed, with general particulars :—

1881. Sir W. F. D. Jervois, of Wellington Station (then Governor of the colony), and now owned by Mrs. M. Bowman, started with a low embankment and reclaimed 3,320 acres against ordinary river floods ; partly sown with grasses, &c., and almost exclusively devoted to stock grazing.

1882—1908. Messrs. W. H. Morphett & Co., of Woods Point, area approximately 2,000 acres. The first swamp was fully reclaimed in 1908, and contains 650 acres ; approximately another 1,000 acres have since been reclaimed. These areas are cropped with lucerne, onions, English barley, the first-named predominating ; the balance is used for grazing and crops also. Besides carrying a large number of sheep, about 350 cows are milked.

1896. The late Mr. Maefarlane, of Wellington Lodge, reclaimed over 700 acres at a cost exceeding £10,000. This land is now used for grazing and carries a very heavy stocking.

1898. Hon. J. Cowan, M.L.C., of Glen Lossie, reclaimed 800 acres, part of which is used for intense culture, although the bulk of the land is devoted to stock-grazing. Some phenomenal heavy hay and fodder crops have been harvested from this area.

1905. Mobilong area, about 480 acres, was protected by the Government from the river overflow with the completion of a levee commenced in 1884. It is divided into 39 blocks, varying from $4\frac{1}{4}$ to 25 acres in extent. In this, as in all other reclaimed areas, wherever the naturally drained lands are cropped splendid returns follow.

The Government Experimental Farm, which contains 40 acres, was established in 1906, with a view of assisting the settlers to successfully solve the problems of drainage and intense culture on this class of country, and under the peculiar natural conditions obtaining. Up to the present many useful lessons have been learnt from the practical experiments conducted on the farm, and with the experience gained still better results may be expected in the near future.

Dairying is the principal industry on Mobilong, as well as on the other areas reclaimed by the Government.

1905. Burdett area, 120 acres, was also reclaimed by the Government. It is divided into 17 blocks, all of which are occupied, and command a high premium, as do all other lands of this class.

1907. Long Flat area was added to the list by the Government. This covers 360 acres, subdivided into 20 blocks.

1909. Monteith area, of about 1,000 acres, was protected from the river overflow by the State, and allocated to 37 applicants. This is one of the richest swamp areas within the Murray Valley, and with proper management on the part of the owners will become one of the show places of Australia in the matter of crop and fodder record yields per acre. Several other swamps of lesser areas than those enumerated have been partly reclaimed, whilst others (including Mypolonga, of 1,833 acres, by the Government) are being converted into rich and fertile estates.

Areas which will be reclaimed at an early date are—Pompoota, 563 acres; and Wall Swamp, 466 acres. At Mypolonga 1,833 acres swamp lands, 1,270 acres of high lands will be irrigated, in addition to which over 3,000 acres will be available for farming blocks.

At Swanport 116 acres have been reclaimed, and negotiations are now proceeding for the purchase of adjoining high lands.

At Berri an area of about 8,900 acres are irrigable, of which 2,070 acres divided into 98 blocks are let on perpetual lease; $79\frac{1}{2}$ acres has been set apart for irrigation experimental work, to assist in securing the highest results from the river lands. The site includes all classes of soil common to the Murray Valley. It is intended to carry on fairly extensive trials with fruit trees and vines of new and approved marketable varieties, fodders and other economic plants, and no doubt many valuable lessons will result. A dry farming plot of $157\frac{1}{2}$ acres is attached to the irrigation farm, the former being above the line of water command. At Kingston approximately 500 acres are irrigable. This settlement contains some exceptionally fine country

for successful irrigation. At Lyrup 540 acres are available for irrigation. Last season the orchards and vineyards produced 260 tons of dried fruit. Waikerie and Rameo were originally village settlements, but the irrigation area has been increased to slightly over 2,500 acres, practically the whole of which is in occupation.

The village settlements were established on the Murray in 1894, mainly from the ranks of the then unemployed. Settlements, including Murtho, New Era, Gillen, New Residence, Holder, and Pyap, were gradually eliminated. In 1899, after an exhaustive inquiry by a Royal Commission, the system on which they were established was abolished, and the remaining settlers were permitted to occupy independent leases, while the water was supplied on a co-operative basis, as at Renmark and elsewhere.

Despite the fact that the village settlements did not turn out an unqualified success, the efforts of the Government of the day in the direction of fostering the irrigation movement resulted in the settlers in question demonstrating the value of river lands for wheat production, with the result that practically a new and particularly prosperous farming district is firmly established on the banks of the Murray.



Hayfield, Adelaide Plains.

SOME INDUSTRIAL PROBLEMS.

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(a) WATER SUPPLIES.

By L. KEITH WARD, B.A., B.E., *Government Geologist*,
with a contribution on Surface Supplies by
C. A. BAYER, M.I.C.E., *Government Hydraulic Engineer*.

THE consideration of problems of water supply inevitably occupies the attention of all who are concerned with the development of South Australia. To the agriculturist or pastoralist the question of water supply is of paramount importance, since water is essential for the successful outcome of his labors. The problems of water supply and distribution are ever foremost in the mind of the legislator in a State in which the greater part of the yearly revenue is derived from the agricultural and pastoral industries, and the topic is one of absorbing interest to the student of economic physiography, especially if he is a visitor from a well-watered country.

The recording of meteorological observations has now been for many years continuous in South Australia, and an average annual rainfall map of the State has been prepared by the Commonwealth Meteorological Bureau. The isohyetal lines on the map which accompanies this article are drawn in accordance with the map issued by the Federal Bureau. An investigation of the average annual rainfall map of Australia will show that the only area within the Commonwealth having an average annual rainfall of less than 5in. lies within the limits of South Australia—the Lake Eyre region. It will also be at once apparent that the proportion of South Australia which has an average annual rainfall of less than 10in. is much greater than the proportion of any other Australian State receiving so small a rainfall.

Reservoirs have been constructed by the Government, and schemes of distribution have been carried into effect throughout the more closely settled parts of the State. These schemes are remarkably impressive when the present population of the districts served is taken into account.

Beyond the areas thus supplied by the Government waterworks recourse is had to privately-constructed surface reservoirs or to subterranean supplies.

SURFACE SUPPLIES.

Adelaide, the capital of South Australia, is situated about four miles west of the Mount Lofty Range and about six miles east of the sea. The ground level at the General Post Office (which is about the centre of the city) is 154ft. above sea level. The water supply for the city and suburbs is obtained from the rain that falls on the water-

sheds of the Torrens and Onkaparinga Rivers, the catchment areas of which comprise about 305 square miles. The average annual fall for the past 20 years on the Torrens catchment has been 30in., and on the Onkaparinga 34in. Selected water only is taken from the catchment areas and stored in the three reservoirs that supply the metropolitan area. Two of the reservoirs, Thorndon Park and Hope Valley, are situated about seven miles north-east of the city, and the other, Happy Valley, about 12 miles to the south.

Thorndon Park was the first reservoir from which the city was supplied; it was constructed in the year 1857, has a holding capacity of 139 million gallons, and the water is obtained from the Torrens River. In the year 1872 Hope Valley reservoir was constructed, to hold 746 million gallons. This reservoir is situated about a mile from the one at Thorndon Park, and is filled from the same catchment.

From these two reservoirs Adelaide and its suburbs obtained a supply until the year 1896, when owing to the rapid increase in the population and the extension of the water carriage system of drainage a further supply became essential. After various schemes had been considered, it was decided to obtain the additional supply from another watershed. The construction of the Happy Valley reservoir was commenced in the year 1891 and the new supply brought into operation in October of the year 1896. This reservoir has a holding capacity of 2,949 million gallons of which 2,558 million gallons are available for the city. It is filled with water from the Onkaparinga River, which is conveyed through a tunnel three and a half miles in length into the reservoir. An embankment, half a mile in length, was constructed across the valley. Two masonry towers have been built, one of which controls the supply to the city, which is conveyed through an outlet tunnel one and a half miles in length, and thence by a 3ft. steel main that supplies three smaller mains leading to the city. The other tower commands the Scour Tunnel through which the pipes to supply the Noarlunga district are also led. Three 18in. cast-iron mains are laid from the old reservoirs for the supply of the city and suburbs.

The high levels, such as Burnside, Mitcham, Magill, &c., obtain their supplies for many months in the year from local creeks, and this is augmented in the summer months by pumping from the main supply. Balance or service reservoirs are constructed in different parts of the district.

The consumption varies from six million gallons per day in the winter to over 16 million gallons per day in the summer time. The water is of excellent quality, and is delivered to the consumers under a good working pressure of 80lbs. to 90lbs. to the square inch. The meter system is in general use, and all premises, where the main is available, are rated on the assessed annual

value. For every 15d. paid in rates 1,000galls. of rebate water is allowed, and for excess above the quantity allowed for rebate the low price of 6d. per thousand is charged for the low levels and 1s. for the high levels.

The population now supplied is about 200,000 persons. The total length of mains laid is about $802\frac{1}{2}$ miles, and the area embraced in the Adelaide Water Districts is $165\frac{1}{2}$ square miles. Ample provision has been made throughout the system for fire brigades to easily obtain a good supply.

The total cost of the works to date amounts to £1,883,450, and the net revenue for the year ending June 30th, 1913, was 4·12 per cent. on the capital cost.

COUNTRY WATER DISTRICTS.

The principal country water districts are the Beetaloo, Bundaleer, and Barossa, in which a number of towns, as well as country lands, are supplied. In these districts there are three large reservoirs, one of which is constructed as a concrete gravity dam, another with an earthen embankment, and the third as an arched concrete dam. The holding capacities are 800, 1,320, and 993 million gallons respectively. Many miles of concrete channels and tunnels convey the water to these storage reservoirs from their different catchment areas of about 724 square miles, upon which the average rainfall for the past 20 years has been 26in. on the Beetaloo, 19in. Bundaleer, and 28in. Barossa. The length of steel and cast-iron mains laid at present in the three districts amounts to 1,963 miles. The present water rate levied is 4d. per acre on all land within the first mile abutting a main, and a special rate is adopted in the towns.

WATER DISTRICTS.

The water districts reticulated with mains of different sizes extend from Aldinga in the south to Port Augusta in the north, and include an area of about 3,260,000 acres. The total length of mains at present laid amount in the aggregate to $3,136\frac{1}{4}$ miles. A good supply has been provided in each of the districts for all landholders, which is of immense value to the farmers as well as to the State. This comprehensive scheme of reticulation is unique in the history of waterworks, and there is probably no other part of the world where so large a district of agricultural land is supplied in so complete a manner for domestic, stock, and other farming purposes.

Several Murray River townships are supplied with water that is pumped from the river into small reservoirs or tanks. Mount Gambier in the South-East is supplied with excellent water pumped from a soakage well at the Blue Lake. Other small schemes have to be carried out for the supply of various country towns, and some of these have been leased to different trusts.

The total capital expenditure on waterworks in this State is £4,863,415, and the percentage of net revenue on capital cost is about 2·69 per cent.

Table showing particulars with regard to South Australian water supplies :—

Name of Water Supply.	Capacity in Galls.	Area Supplied.	Population Supplied.	Miles of Existing Mains.	Date of Completion of Reservoir.
<i>Adelaide and High Levels—</i>		Sq. Miles.			
Happy Valley	2,950,000,000	—	—	—	1896
Hope Valley	807,000,000	165½	200,000	802½	1876
Thorndon Park	138,000,000	—	—	—	1858
<i>Service Reservoirs—</i>					
Magill tank	56,000	—	—	—	1887
Burnside tnks. (2) upper	1,270,000	—	—	—	1879 & 1903
South Burnside tank ..	550,400	—	—	—	1880
Waterfall Gully	569,600	—	—	—	1881
Mitcham tank	270,000	—	—	—	1883
Kensington pmpg. stn.	258,000	—	—	—	1882
North Adelaide	1,000,000	—	—	—	1879
Glenelg	850,000	—	—	—	1875
<i>Barossa, including Country Lands and Towns—</i>					
Barossa reservoir	993,347,000	1,046	53,000	568½	1902
<i>Service Reservoirs—</i>					
Redbanks	10,000,000	—	—	—	1909
Gawler	279,000	—	—	—	1880
<i>Beetaloo, including Country Lands and Towns—</i>					
Beetaloo reservoir	800,000,000	1,691	32,000	928½	1890
<i>Service Reservoirs—</i>					
Paskeville (2)	} 43,000,000	—	—	—	1887 & 1908
Barunga		—	—	—	1890
Milcowie		—	—	—	1897
Gladstone		56,000	—	—	1889
Nelshaby		23,123,000	—	—	1875
Port Germein		1,500,000	—	—	1888
<i>Bundaleer, including Country Lands and Towns—</i>					
Bundaleer reservoir ..	1,320,000,000	1,048½	7,000	483½	1902
<i>Service Reservoirs—</i>					
Ingram's Gap	14,250,000	—	—	—	1904
Peak Springs	1,494,000	—	—	—	1886
<i>Country Water Districts—</i>					
Reservoirs (12)	} 445,834,000	—	—	—	—
Weirs (3)		—	—	—	—
Tanks (13)		—	—	—	—
Pumping stations (4)....		—	—	—	—
Wells (3)					
<i>Districts under "The Water Conservation Act, 1886"</i>					
Reservoirs (3)	} 231,069,000	—	—	—	—
Weirs (2)		59½	—	55	—
Tanks (5).....		—	—	—	—
Pumping stations (4)....		—	—	—	—
Totals	7,783,000,000	5,093½	—	3,136½	—

UNDERGROUND SUPPLIES.

From the map which accompanies this article it will be seen that there are a number of artesian basins within the limits of the State. The distribution of underground water is, however, by no means restricted to these areas, in which special conditions exists. It is proposed to give a brief account of the ordinary ground-water supplies of the State. The distinction between ground-water and artesian or subartesian water lies in the fact that the former is subject only to the pressure of the atmosphere, while the latter is under a pressure exceeding that of the atmosphere, and will rise above the level at which it is encountered when tapped by a bore or well.



Barossa Reservoir.

(a) GROUND-WATER SUPPLIES.

These supplies are directly dependent upon the rainfall in the immediate district in which the wells are located. The quantity and quality of the water depend upon the meteorological, topographical, and geological conditions existing in the particular area concerned. Special stress is laid upon these conditions for the reasons that the total annual rainfall over the greater part of South Australia is small, evaporation is considerable, and run-off is negligible in almost every district. Any detailed map of South Australia shows that almost every defined stream which takes its rise in the ranges dies out almost at the point of its debouchure on the plains. Many of the streams, especially in the central and northern parts of the State, belong to

drainage systems which have no outlet. The "cyclic salts," washed from the atmosphere by the rain, are concentrated within these basins of internal drainage at the lowest levels attainable, or are carried slowly towards the sea along the deepest buried channels that have an outlet. The search for useful water supplies from beneath the surface is, in South Australia, largely controlled by the necessity for the avoidance of the low-level salt.

The best supplies are those which are obtained within the regions of greatest rainfall, viz., the South-Eastern portion of the State and the Mount Lofty Ranges. In the first-named region the distribution of ground-water is practically universal, since there is an extensive terrain of porous limestone at or near the surface. In the hills the rocks are for the most part highly altered and close-grained sediments, and the wells depend for their supply upon fissure-systems.

Many good supplies of underground water are obtained in all parts of the State from loosely aggregated alluvial deposits. These wells in alluvial deposits are usually referred to as "soaks," and are located either at the foot of bare, rocky slopes or in the beds of rivers and creeks. Many of them are shallow, and the water is held up by a thin layer of impervious clay. In the main valleys of the Flinders Range this type of well is common, and proves the most reliable source of supply.

The deeper and more extensive alluvial deposits which occupy the greater part of western Eyre's Peninsula between the Gawler Ranges and the sea have been geologically examined with the object of obtaining from them useful supplies of water for the settlers, and it has been found that there are some features of peculiar interest. The area is one in which the outcrops of the granitic bedrocks are few and scattered. The correlation of the data obtained from wells and bores throughout this region shows that these outcrops are the highest points of a dissected granitic land surface. The sediments which have almost completely obliterated the granite terrain are porous and absorbent, save where local beds of clay are developed, and no surface drainage systems exist. Yet, although there is no actual run-off, the greater part of the ground-water is salt. The salt content of this water is considered to be due to the washing out of the accumulated "cyclic salts" by exceptionally heavy falls of rain which drain from the Gawler Ranges, to be further concentrated in the salt lakes which form a fringe round the southern front of these ranges. The remainder of the run-off, with its load of "cyclic salts" thus proportionately increased by concentration, moves seawards along the buried valleys of the granitic terrain.

All the waters, therefore, of the deeper portions of these valleys are salt, and useful supplies can only be obtained where the rain water absorbed by the porous sediments has not suffered vitiation by admixture with the main salt underflow.

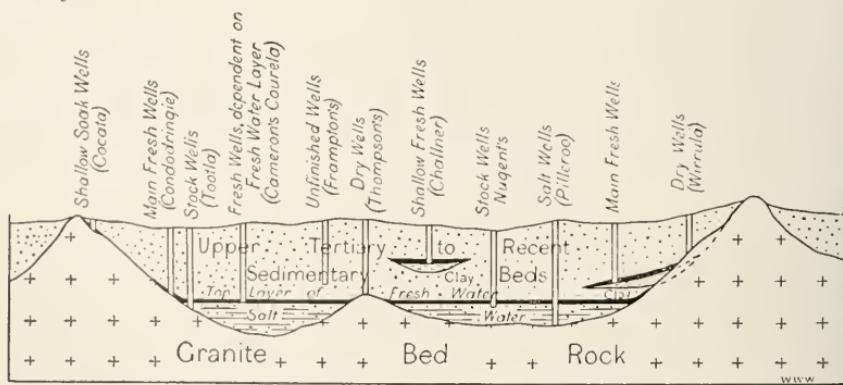
These useful ground-water supplies may be obtained from—

- (1) Areas in which there exists a buried impervious bed of clay which intercepts and supports the percolating water above the main salt water table, or
- (2) Zones which follow the contours of the granite bedrock, immediately above the level of the salt water filling the deeper valleys.

In the former case it is a necessary condition that the impervious layer should be situated at a sufficient depth beneath the surface to prevent direct evaporation and the return of the water to the atmosphere by capillary action or the transpiration of vegetation. These "suspended water tables" are in certain areas quite extensive, and from them large supplies of excellent water are obtainable. The only visible indication of their existence is a notable development of massive tabular travertine, which results where a relatively shallow bed of impervious clay exists below the surface. The more deeply buried clay beds are not indicated by any superficial signs.

The narrow zones of fresh water on the slopes of the buried granite hills and ridges are in reality deeply-seated soakage wells, and have afforded supplies of useful water to the amount of from 1,000 to 2,000 gallons a day.

In a few cases, where great care has been exercised in sinking the wells, it has been possible to make use of the top layer of fresh water which has percolated through the porous soil and rest upon the main body of salt water. Such supplies have in all cases been small, and in many instances the quality of the water has been spoilt by deepening the well in order to increase the quantity.



DIAGRAMMATIC SECTION. SHOWING CONDITIONS UNDER WHICH DIFFERENT TYPES OF WELLS OCCUR. WESTERN PORTION OF EYRE'S PENINSULA.

These occurrences of ground-water in the country lying between the Gawler Ranges and the western coastline of Eyre's Peninsula are illustrated by the diagrammatic section printed herewith. A more detailed account will be found in Bulletin No. 1 of the Geological Survey of South Australia.

Another source of ground water supplies is afforded by the sandhills in all parts of the State. The sand permits the rain water to sink rapidly beyond the reach of dissipating agencies until it comes to rest upon an impervious stratum or upon salt water. Such conditions occur not only on the coast, but also in the arid interior where wind-swept sands accumulate in dunes.

Before passing on to the consideration of artesian water it may be mentioned that the criteria of utility with regard to the quality of water are, in South Australia, by no means so rigid as in better-favored countries. It has been found as the result of long experience, that horses will work and keep their condition on water containing up to 1oz. of solids to the gallon, and that they can live if as much as $1\frac{1}{4}$ oz. of solids are present in a gallon of the water. Cattle will live on water carrying $1\frac{1}{2}$ ozs., and sheep can exist on water containing as much as $2\frac{1}{2}$ ozs. of solids to the imperial gallon. It is customary to refer to water containing not more than 1oz. of solids to the gallon as "stock water," but this limit is very often exceeded, as the figures cited above show. The use of mineralised water by settlers themselves in times of dire necessity indicates remarkable powers of endurance. Water containing as much as 1oz. of solids to the gallon has been used for domestic purposes for considerable periods, and the writer has been assured that "good tea" could be made from water which proved on analysis to contain 1.14ozs. of solids per gallon. In all of these cases to which reference has been made sodium chloride is the principal constituent of the "solids," and it is found that when salts of magnesium are present a lesser amount of total solids is permissible.

(b) ARTESIAN AND SUBARTESIAN WATER SUPPLIES.

The following account of the artesian basins of South Australia is based upon the records of boring operations and results of those bores only which have been drilled under Government supervision. The areas occupied by these basins are indicated in color upon the map which accompanies this article.

It will be seen by a glance at the map that there are a number of basins and that the three largest of them extend beyond the limits of South Australia. As far as is possible, the following account is restricted to the South Australian portions of those basins which extend into the adjoining States, and to the whole of the smaller basins entirely included within South Australia.

(1) *The Great Australian Basin.*

The south-western portion only of this, the greatest known basin in the world, lies within the boundaries of South Australia, the greater part of the remainder of the basin lying within the States of Queensland and New South Wales.

The South Australian portion of the basin occupies an area of 112,110 sq. miles, as determined by planimetical measurement on the attached map.

In form, the whole basin approximates to the ideal type of a complete basin, the eastern rim being tilted up to a greater altitude than the western. Some portion of the water content of the basin escapes northwards into the Gulf of Carpentaria, and another portion is continuously discharged at the surface round the south-western border. This natural discharge takes place by means of the so-called "mound-springs" which are distributed in groups round the margin of the basin at points where the hydraulic pressure suffices to force the water to the surface. The distribution of the mound-springs is shown upon the map accompanying this article.

The greater part of the water enters the basin on the western scarp of the eastern Australian highlands, and has been clearly shown to flow in a general westerly and south-westerly direction towards South Australia. A smaller amount is probably absorbed by porous beds which outcrop in the valleys of the Goyder and Finke Rivers to the west and north-west of Charlotte Waters (N.T.).

The water-bearing beds are, for the most part, of Lower Cretaceous age; but still older rocks have been shown to underlie these and to carry saturated strata which contribute to the supply.

Over the greater part of the basin artesian conditions prevail; but towards its western limit there is a loss of head sufficient to cause the hydraulic surface to dip beneath the earth's surface. In consequence of this loss of head the Imbitcha, Mirakina, Breadon, Blood's Creek, and Charlotte Waters (N.T.) bores are subartesian. Mound-springs can only occur where the hydraulic surface (*i.e.*, the surface containing the points to which water will rise above sea level) lies above the earth's surface, and artesian conditions therefore prevail within the line of the existing mound-springs.

The bottom of the basin is irregular, and the irregularities are most prominent at the edge of the basin where promontories projecting into the old Cretaceous sea or actual islands are visible. The depth of the basin decreases gradually towards its margin; but the uneven surface of the bedrock at a few points causes an apparent departure from the general shelving of the bottom.

The water is of good quality, and is suitable for stock and even human consumption in the great majority of cases, though a few bores, such as Tarakanina, Margaret Creek, and Mirrabuckina are salt. The total amount of solids present per gallon in the water of useful bores varies between 735 grains (Lake Crossing) and 55 grains (Kopperamanna), the average of the analyses

of samples taken from 32 bores and springs being 220 grains per gallon. The substances most abundant in the majority of samples are sodium, chlorine, and carbonic acid.

In a few places, notably in the Coward, Oodnadatta, Hamilton Creek, and Lake Crossing bores, and in the springs at Strangways and The Peake, the proportion of sulphates present in the water is considerable.

The temperature of the water is noticeably high throughout the basin, and extremely high in its deeper parts. The temperature gradient for the bores on the edge of the basin is very steep, doubtless from the fact that the water is ascending towards the surface from great depths. The temperature gradient at Coward of 10·32 should therefore be viewed in relation to the gradients at Mount Gason and Goyder's Lagoon, which are respectively 31·75 and 33·7.

In the north-eastern corner of the State the pressure forcing the water to the surface is very great, for here the hydraulic surface rises very high above the surface levels of the earth. The combination of high temperature with high pressure in this region makes it a very difficult matter to properly control the flow, when once the drill has penetrated to the water-bearing horizon.

From the Government bores which tap the South Australian part of the great basin, it is estimated that the total daily flow is 12,393,200galls.

The representation of these facts upon the map accompanying this article has been effected with all possible care, but there are several reservations which should be made, and some explanations that should be given.

In the first place the boundary of the basin is exceedingly difficult to define, save where the palaeozoic bedrocks outcrop and have been shown upon the geological map of South Australia prepared by Mr. H. Y. L. Brown. Where the water-bearing beds are wholly or partly covered by later sediments the boundary cannot be accurately shown. The evidence of the existence of mound-springs and the observed shelving of the bottom of the basin have then been taken into account.

The occurrence of the outlying mound-springs known as Ross' Springs suggests the extension in that direction of some narrow arm of the basin, which does not contain useful supplies of water at the site of the single bore near Lake Phillipson. This bore penetrated to bedrock (granite) at a depth of 3,161ft., and the only water encountered was salt (4ozs.), rising from a depth of 743ft. to within 85ft. of the surface. Some attention has recently been attracted towards this question of a possible south-westerly extension of the Great Australian Basin by the discovery of water-bearing beds in the deeper part of the Eucla Basin which contain fossils identical with those of the Great Basin. This evidence points strongly to the existence of some communication between the two basins, even if this communication is not direct.

The group of perennial springs shown on the map to the west of Lake Frome seems very probably to mark the western limit of an extension of the basin to the south of the area included within its limits. Judgment on this matter has been reserved.

(2) *The Murray River Tertiary Basin.*

The whole of the south-eastern portion of South Australia is occupied by this basin, which has been formed by the filling of a depression which formed in Tertiary time a great bay extending into south-western New South Wales and north-western Victorian. The subsequent displacement of the strand line has left this broad basin at no place very high above sea level.

In form, therefore, the basin is of the type usually found in valleys, but it is exceptionally broad, and has an outlet to the sea off the southern coast of South Australia.

The water enters the basin at a number of places round the rim, and the intake beds at no point attain any considerable altitude above sea level. It is thought that the Darling River may supply some portion of the water to the lower beds of the basin which are exposed in the channel of that river. In like manner some of the rivers and creeks in South Australia, such as the South Rhine River, Burra Creek, Yunta Creek, and Olary Creek, may bring in a contribution from the north and west.

At the recent inter-State conference on artesian waters it was shown by Mr. A. S. Kenyon, of the State Rivers and Water Supply Commission of Victoria, that no small proportion of the water enters the basin from the south.

Mr. Kenyon showed that in the southern part of the county of Lowan, in Victoria, there is an area of nearly 2,000,000 acres from which there is no run-off on the surface, even in the wettest seasons, while the average rainfall on that area is about 25in. per annum. The map of the region showing the isopotential lines plotted by Mr. Kenyon proves that this water flows northwards, north-westwards, and westwards.

It seems beyond doubt that this Victorian source supplies the best water in the South Australian part of the basin.

The rocks which occupy the depression are for the most part of Tertiary age, and are partly of terrestrial and partly of marine origin. They attain a depth of some 1,800ft. in the deepest part of the basin, and cover an area of 26,800 sq. miles within South Australia.

Over almost the whole of the basin the relationship between the hydraulic surface and the ground level is such that the water will not flow over the surface. Several artesian bores exist at Tintinara, but even at this place the flow is relatively small unless aided by pumping. The other bores are subartesian, and the supply of water is apparently sufficient at the present time to sustain a large demand.

The irregularities in the bottom of the basin are sufficiently pronounced to cause the projection of "islands" of the bedrocks at several places.

The quality of the water in the southern bores is, on the whole, very good ; but in some instances supplies of salt water were met with at shallow levels. These have, in a few places, been successfully shut off by the casing of the bores, and the deeper fresh waters only have been pumped.

In the more northerly bores the quality varies from poor to bad ; and it seems highly probable that this salt water is derived from a source other than that of the fresh water flowing northwards from Victoria.

The work which has been carried out in the latter State strongly supports this hypothesis.



Artesian Bore, Far North.

(3) *The Eucla Basin.*

This basin is one of the typical "one-sided" type, sometimes referred to as an "artesian slope," and commonly developed in a coastal region. The outlet is to the sea along the Great Australian Bight.

The intake beds appear, from published descriptions of the area, to outcrop at the surface round the northern fringe of the Nullarbor Plain, where they receive a scanty rainfall. It does not appear quite certain whether there is any material subterranean contribution to the basin from the highlands of north-western South Australia ; but it is established that no surface streams issuing from the northern ranges reach the intake beds of this basin.

The area of the part of the basin which lies within South Australia is 21,100 sq. miles, and the maximum depth of the water-bearing rocks penetrated by the bores is 1,500ft. The upper part of the sediments which fill the basin are of the Tertiary age ; and the lower series have, by evidence recently derived from the Western Australian portion of the basin, been determined to be of Lower Cretaceous age.

Over almost the whole area the water tapped by the bores will not ascend to the surface ; but one artesian bore giving a small flowing supply is reported from Western Australia.

The “islands” of bedrock, which are characteristic of the other basins, are in this one less numerous. A few are known to exist near the eastern boundary.

The quality of the water, so far as it has been tested, is not very good. Nothing better than stock water has been discovered ; but it should be noted that marked variations in the quality of the water are known to exist within very short distances, and the importance of the existence of even stock water in this region is not to be exaggerated.

The quality of the water being poor, tests were not made in all instances of the quality to be obtained by pumping. However, from Roberts’ Well, the nearest bore to the head of the Bight, the water rising from a depth of 749ft. to within 135ft. of the surface, a pumping supply of 68,000galls. per day was obtained.

The value of this subterranean reservoir in a region where no surface water exists is very great, especially as the surveyed route of the Transcontinental railway line between Kalgoorlie and Port Augusta traverses the surface of the basin. It is possible that water of better quality exists in this basin at some points nearer to the intake, and it is important that trials should be made in view of the necessity of supplying water for the use of the railway.

(4) *The Adelaide Plains Basin.*

This basin also is of the one-sided type, and is developed along the margin of the Mount Lofty Ranges, on the eastern shore of Gulf St. Vincent.

The water enters the basin at the foot of the ranges and probably finds an outlet to the sea within the gulf. The height of the intake beds does not appear to rise at any point much over 600ft. above sea level.

The rocks of the basin are of Tertiary age, and occupy a long trough bounded on the east by a series of faults. The eastern portion of the basin shows by the great variations in the depths of the bores that there are platforms or steps along the fringe of the area of subsidence.

The total area of the basin, which extends from Brighton on the south to Port Wakefield on the north, is approximately 1,000 sq. miles.

Many bores have been put down within its limits, but only a few of them were sunk by the Government. The majority are subartesian bores, but in some cases—as at Croydon and Dry Creek—flowing supplies were obtained. The former of the bores mentioned has become subartesian from the diminution of the pressure, and no recent data with regard to the latter, which is a private bore, are available.

The quality of the water is, in the majority of cases, good, but at the northern limits of the basin salt supplies were struck.

The rainfall on the intake is on an average about 15in. per annum, but the streams which probably feed the basin flow from the hills, which receive 25in. or more of rain annually.

(5) *The Willochra Valley Basin.*

The valley of the Willochra Creek, which finds an outlet through the Flinders Ranges to Lake Torrens, has a well-defined fall towards the north, and contains a valley basin. There is a fall of 550ft. between Booleroo Centre, at the southern end of the valley, and Bruce, and another 100ft. between Bruce and Willochra.

The intake beds probably absorb their water from the numerous tributaries of the Willochra Creek, which rise in the high, bare hills forming the walls of the valley. These hills exert a powerful influence upon the rainfall, which is much higher on the western than on the eastern side of the valley.

The effective area of the basin has not been fully determined, and the map accompanying this article shows only the central part of the Willochra Valley as an artesian basin with an area of 320 sq. miles.

The basin contains both artesian and subartesian bores. The Bruce bore is artesian, but gives only a small supply unless assisted by pumping, when the output may be raised to 96,000galls. per diem. The Willochra bore was formerly artesian, but has become subartesian.

The quality of the water is for the most part good, but at Hammond, on the eastern side of the valley, the water carries 1½ozs. of salts to the gallon.

(6) *The Port Pirie Basin.*

There is very little available information with regard to the Port Pirie basin, in which two State bores have been put down, one at Port Pirie and the other at Stirling North.

It appears from the records of these bores that the coastal plains are built up of a considerable thickness of sediments in which terrestrial deposits are interstratified with deposits of marine origin to a depth of at least 600ft. in places.

The northern and southern extensions of the basin beyond the bores to which reference has been made is unknown. The deposits of the coastal plains are probably of Upper Tertiary to Recent age, and detailed investigations are necessary before the basin can be fully delimited.

It is noticeable that the deepest water of the Port Pirie bore is brackish, containing 1oz. of solids to the gallon. This water was met at a depth of 574ft. and flowed over the surface. The flow was at first large—500,000galls. per diem—but diminished to 50,000galls. per diem.

The water from the Stirling North bore was very brackish. Artesian conditions prevailed at the time when the water was met, but the bore has since become choked.

It is probable that the water of best quality in this basin will be found near the eastern margin of the plains at points opposite to the debouchures of the principal streams which have their gathering ground in the Flinders Range. These wells or bores may not afford flowing supplies. The southern portion of this basin is more advantageously situated than the northern by reason of the greater rainfall which it receives.

(7) *The Cowell Basin.*

A brief mention should be made of this basin, which has the typical structure of a one-sided artesian basin ; but its utility is, unfortunately, almost negligible on account of the salt which is present in the water.

The subartesian bores at Cowell and Carpa are the only bores in the basin but dug wells have been put down at a few points.

The water entering the intake beds is for the most part salt, and the only useful wells which exist in the basin are situated close to the western fringe, and at the debouchures of the torrential streams as they leave the ranges.

The water-bearing beds of the basin are of Upper Tertiary to Recent age some of them at least being deposited under marine conditions.

The essential differences between this basin and the Port Pirie basin on the other side of Spencer Gulf are due to the relatively lower rainfall on the area supplying the intake beds of the western basin and the concentration of salt in the main body of the water of this basin.

The area occupied by this basin is 610 sq. miles.

(8) *Other Basins.*

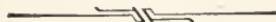
It is probable that a number of smaller basins exist in this State, but there is little official information available with regard to them.

Thus, a valley basin appears to exist to the east of the Willochra Valley. The Orroroo bore in this basin proved the existence of a large supply under sufficient pressure to force it over the surface. The Gallway bore, however, was a failure, probably for the reason that it bottomed on the eastern slopes of the filled valley above the level of the water-bearing beds. This basin, which may be termed the Walloway Plains basin, perhaps, extends towards the north as far as the northern boundary of the hundred of Bendleby.

A subartesian well at Eurelia has given a supply of 2,000galls. of useful water per diem; but details with regard to it are unknown.

Again, at Snowtown, subartesian supplies of fair quality have been proved to the amount of 22,000galls. per diem. At Percyton, in the vicinity of Snowtown, a subartesian supply of 12,000galls. per diem has been obtained, and the water is of useful quantity.

The valley of the Siccus River, which flows into the southern end of Lake Frome, as well as the valleys of its branches, probably contain supplies of underground water that will prove useful. No official examination of this area has yet been undertaken.



(b) QUESTIONS AGRICULTURAL AWAITING SCIENTIFIC
RESEARCH.

—o—
BY W. LOWRIE, M.A., B.Sc., *Director of Agriculture.*

(a) The bacteriology of soils under South Australian climatic conditions.

In this relation, the maintenance of a supply of nitrates in the soils of the State is of great importance. Although analytical results seem to indicate that nitrogen is present at any time only in fair quantity, and although much of the land has been severely cropped with wheat for more than 40 years—for many years in that period without the application of manure of any form, and latterly with the application of soluble phosphates only—yet the direct use of nitrogenous manures produces little or no gain in yield, and its application is almost invariably unprofitable. This condition of things is probably accounted for by the greater activity of the nitrogen-fixing and nitrifying ferment which a warmer climate secures, provided moisture be conserved. The thorough fallowing adopted in general practice makes for this result, and probably in a three-years system of cropping—fallow, wheat, grazing—the gain of nitrogen which results from the leguminosae which come up adventitiously in the stubble herbage is appreciable. Again, as the land is not under-drained, and the leaching of nitrates by excessive rains is relatively small, the maintenance of nitrogen adequacy is so much easier. There is, however, a practice prevalent in certain districts of cropping the land every two years—wheat and fallow alternating—and severe as this practice may be thought to be in burning up the humus by the repeated fallowings, yet when a sufficiency of phosphates soluble are applied, there is no evident diminution of the yield. To still further decrease the organic matter in the soil under this practice of cropping with wheat once in two years, unless the wheat be cut for hay, the straw stubble must be burned in the autumn before the dry season ends to allow of fallowing in the following winter. It might be fairly anticipated that a practice so exhausting of organic matter, humus, and nitrogen would, in a few years, prove disastrous unless direct nitrogenous manuring was adopted; yet, so far, in these cases, crops up to the average of the district are being secured, and in the better districts, such as Tarlee, crops yielding 22bush. to 27bush. are reaped on an average rainfall of 18in. to 19in., and practically as good as at any time in the history of the district. In all probability trouble will arise later, but it is not, so far, directly foreshadowed.

How are the necessary nitrates being provided and maintained? The whole problem lies waiting the systematic investigations of bacteriologist and chemist, and the full solution of the question may prove of great economic

importance, or there may be revealed bacteriological activities such as are not found in colder countries where such researches have hitherto been made.

(b) The extraordinary results secured by the use of soluble phosphates applied with the seed in South Australia on the yield of wheat.

For example, over a series of years, wheat and fallow alternating, the average gain from the application of 1cwt. superphosphate per acre, compared with no manure, was 7bush. per acre, the respective yields being 27bush. 19lbs. and 20bush. 9lbs. on an average rainfall of 20in. per annum. This result is not exceptional, and in some districts of the State the gains from dressings of soluble phosphates, relatively light though they be compared with the quantities used in Europe, may be even greater—up to 50 per cent. increase, or even 100 per cent. The effect is to some extent explained by the fact that much of the land, having been cropped for many years from the days of pioneer settlement without the application of manure of any form, was consequently in need of fertilising more especially with phosphatic manures, and by the fact that chemical analysis of the soils reveals them weak in phosphoric acid almost generally, even virgin land being relatively low in percentage of that ingredient. Further, superphosphate is, of course, particularly adapted for use under the light rainfall and suited to the extensive areas of calcareous soils ; but, allowing for its value as a plant nutrient, under the circumstances the results seem to indicate that it functions directly or indirectly in other ways, for it is found that soils comparatively well supplied with phosphoric acid respond to its application to a degree not much less than soils much poorer in that ingredient, and that even on new land of high quality broken up from the virgin state and similar to that which in the past carried a long succession of crops of wheat without manure the use of soluble phosphates considerably augments the yield. The advantages, further, that accrue from the fact that superphosphate stimulates vigorous root growth are not to be overlooked in this climate. Crops treated with it at seed time grow more freely in the winter months, when the surface soil is waterlogged and cold, as they are started more strongly while the soil yet retains its autumn warmth, and are deeper rooted. This power to hasten maturity which superphosphate exhibits everywhere is specially important here, as a burst of hot weather frequently occurs in early summer (shade temperature over 100°F.) when the crops are in bloom or in process of filling, and when such conditions happen the crops most advanced suffer least. Early maturity also lessens the risk of rust, as the grain may be almost filled before the conditions favorable to rust supervene. Further, the vigorous and deeply-penetrating root system encouraged by soluble phosphates enables the plant to withstand better the dry weather or partial drought that frequently prevails in early summer during the critical period of its growth—the period of maturation—through securing moisture from deeper layers of soil or subsoil.

But all these considerations do not seem to account fully for the phenomenal increase that a light dressing of superphosphate frequently secures, compared with the return from similar land unmanured. The opinion is therefore hesitated that superphosphate applied at seed time has a multiple significance and somewhat complex effects, biological and physiological, on the wheat crop or in the soil that either do not obtain, or some of them are more or less masked, in colder climates. During long spells of dry weather, when unmanured crops may begin to flag, crops treated with superphosphate will continue in fair growing vigor, and the thought is suggested that the soluble phosphates modify the physiological activities of the plant so that the transpiration of water necessary for the elaboration of a unit of dry matter is diminished in quantity. Indeed, what was found by Lawes and others long ago to obtain in respect of mineral manures, viz., that the transpiration of water by cereals to which they were applied was diminished, seems to hold here as the result of the simple application of soluble phosphates. In relation to the limited rainfall of South Australian wheat areas this is a very important consideration, but the question so far has not been scientifically investigated. The hypothesis may be put in another way, viz., that the application of superphosphate enables the wheat crop to produce a given weight of dry produce, with the use of less water in the process. It seems to help to explain results that have been obtained on low rainfall in the State, for example, a crop of 22bush. per acre with a 12in. rainfall for the year.

Further, there is some reason to think that dressings of superphosphate, by nourishing nitrifying organisms and encouraging ferment activity in the soil, help to maintain the supply of nitrates. Some confirmation of the hypothesis is derived from the results of investigations made by Paterson and Scott, which showed that soluble phosphates increased the nitrification of ammonia.

These two questions, inter-related to some extent—the question of the maintenance of nitrogen and the question of several relations, direct and indirect, in which superphosphate functions—have very important practical bearings on the rural economy of the State. They await extended research, chemical and biological.

Some other questions, common to science in relation to agriculture, of immediate interest in this State, may be enumerated—

(a) The utilisation of ironstone soils of low grade.

In this State there are localised areas of such land, *e.g.*, part of Kangaroo Island, some of the country north of Port Lincoln, and in the neighbourhood of Mount Compass, which for the time being are practically outside the margin of profitable occupation for purposes of mixed farming. It would seem probable that they may be utilised to some extent for apple-growing or limited fruit culture, but for general farming they have so far proved impracticable.

The soils do not respond profitably to dressings of artificial manures, however varied or blended. Farmyard manure is most successful, but that is not available in sufficiency, and even farmyard manure produces somewhat disappointing results. There are factors governing fertility independent of the plant nutrients, and exercising an inhibiting or poisonous influence on the roots of crops which are difficult to ameliorate or control in view of land values ruling.

Probably, as has been pointed out by Hilgard, the presence of ferroso-ferrie hydrate, associated with a solution of ferrous carbonate occurring in such soils under badly drained conditions, is the primary cause of sterility; but under-drainage is not economically practicable, as it would cost more than would buy good land in other parts of the State, and surface drainage and applications of lime, which under the circumstances are indicated, have so far failed to relieve the trouble profitably, though some improvement has been secured.

(b) The degree of salinity and the percentage of different salts in stock water compatible with healthy conditions.

Much observation, analysis, and the collection of data have yet to be made and the facts considered in relation to the prevailing forage before the question can be properly answered. It is, however, a question of very considerable importance under our climatic conditions.

(c) The degree of salinity to be tolerated by different crops and fruit trees in water to be used for irrigation requires to be studied in relation to local conditions of rainfall, rate of evaporation, and under-drainage.

Most questions engaging attention elsewhere, such as wheat-breeding, conservation of soil moisture, motor traction on the farm, are, of course, equally pertinent in South Australia, but need no particular reference.

(c) PLANT PATHOLOGY.

By T. G. B. OSBORN, *Professor of Botany in the University of Adelaide.*

The following brief account of some of the more prevalent plant diseases in South Australia has been drawn up at the request of the editors. The writer feels obliged to point out that since his residence in the State has been so short, there must of necessity be much incompleteness in the account.

The fungus diseases to which plants are subject in this State are on the whole very similar to those of the neighboring two eastern States, though South Australian growers benefit to some extent by the greater dryness of their climate.

Most of the diseases prevalent among cultivated plants are common to these plants all the world over; some, however, have assumed proportions of greater importance, while on the other hand other diseases common in the Northern Hemisphere in similar climates are absent. An example may be found in the wheat diseases, thus *Ophiobolus graminis* ("take-all") is a very serious pest in South Australia, while *Puccinia glumarum* is not found.

It will be convenient to consider a few of the more important diseases in relation to the crops they affect.

DISEASES OF CEREALS.

There are in South Australia two wheat-infecting rusts, *Puccinia graminis* and *P. triticina*. The latter is common in most places during the winter months, but since the leaves of the wheat plants only are attacked, and those rarely severely, it has not much economic importance. Black rust (*P. graminis*), on the other hand, may assume serious proportions, for in cases of a virulent, outbreak the stems are attacked and the ears consequently impoverished. Fortunately the seasons in which rain falls to any extent during the two months immediately preceding harvest are rare. The dull, damp weather so favorable to the spread of rust is usually absent, so that the crop may be harvested with little disease. There are, however, seasons when suitable weather prevails for the rapid spread of the fungus, and it becomes necessary to cut the crop green for hay to avoid serious loss. A general problem that South Australia shares with the rest of the civilised world is the breeding of a rust-resistant wheat. At present none of the so-called immune varieties are

resistant to *P. graminis* in a "rusty" year, though there are degrees of virulence in the attack. In view of the differing climatic conditions obtaining in the various wheat-growing parts of the State it is possible that no one variety will prove equally satisfactory for all the agricultural areas. This can only be ascertained by such experiments as are being carried out in the various Government farms throughout the State. A second problem that South Australia shares more especially with the other Australian States is that concerning the life cycle of *P. graminis*. The complete life story with its alternation of host plants (aecidia on barberry, uredospores and teleutospores on wheat) cannot exist, for the barberry is practically absent throughout the Commonwealth, and experiments to artificially produce aecidia upon it from the Australian produced teleutospores were fruitless (1). Since we have every reason to suppose that the basidiospores arising from the teleutospores can only infect *Berberis* we may presume that in Australia they are functionless, and that there is no intermediate host of the rust. It seems probable that under Australian conditions the uredospore alone is the functional spore. There are, however, special climatic conditions that must also be remembered. Wheat is sown in May and reaped in December. The season when none is growing is therefore the summer, and the question which arises is not "Are the uredospores viable after the winter?" but "Are they able to withstand the prolonged drought of summer?" Such evidence as we have at present is against the possibility of the uredospore surviving the heat and drought of summer on the dead straw. There is, however, always a certain amount of self-sown wheat in the paddocks at practically all times of the year; it seems possible the rust may "carry over" on this. Moreover, though *P. graminis tritici*, Eriks. and Henn. will not infect most other cereals it is recorded on species of *Hordeum*, *Agropyron*, *Elymus*, and other grasses. It may be that some of these plants help the rust to bridge the adverse summer period.

What has been said of rust in wheat applies in general to the other grain crops, of which the more important are oats and barley.

Of the various ustilaginous fungi infecting cereal crops, *Urocystis tritici*, Koen. appears to be the most important, causing the "flag smut" of wheat, often known by the misleading name of "black rust." This fungus, which was at first regarded as identical with the "stem smut" of rye (*U. occulta*), was later recognised as distinct by Koenerk. McAlpine has shown that infection of the host plant occurs at the seedling stage before the wheat appears above ground. Infected plants rarely come into ear. The smut is usually found upon the leaf blades and sheaths, which may be almost black owing to the numerous areas in which the spores develop, following the mesophyll

(1) McAlpine, D., 1906, "The Rusts of Australia," p. 66.

between the veins. The spores are well able to retain their germinating power in the soil from one wheat season to the next, and are also able to pass uninjured through cattle and horses. "Flag smut" is therefore a difficult disease to control once the soil has become infected.

A third cereal disease of considerable importance is that caused by *Ophiobolus graminis*. The signs of disease are a general dying of the crop in patches, usually either when a few inches high ("take-all"), or at a later stage when in ear, but before the grain has set. The heads then are pale-colored and the ovaries aborted. This form of the disease is known as "white heads," but both are known to be manifestations of the same fungus.

Infection of the roots takes place in the soil at the seedling or a rather later stage. The infected roots develop an abnormal number of root hairs and finally die. The fungus spreads to the lower nodes and leaf bases, which are killed, becoming a black color owing to the investing mycelium. Later there is a development of numerous perithecia, with long and somewhat curved necks. In Britain oats is also attacked, but Australian experience shows that this crop is not injured by the disease, the plants growing well in the paddocks on "take-all" patches. Barley is attacked almost as severely as wheat, and McAlpine has recorded infection of *Bromus sterilis* and *Agropyron scabrum*. Certain meteorological and soil conditions at and before the time of sowing the crop appear to exercise considerable influence upon the prevalence of "take-all"; thus a "working of the fallow dry" preparatory to sowing may be followed by such a severe outbreak as to be popularly regarded as the cause of disease. There is no doubt that in a dry season "take-all" is more prevalent than in a wet one; moreover wheat grown in light, sandy soils appears to be much more frequently attacked than that on heavier land. *Ophiobolus*, like all fungi which attack plants from the soil, is very difficult to combat. Wheat usually follows wheat in South Australia after a year's fallow, so that it is difficult to starve out the fungus, though it has been recommended that oats should take the place of wheat for a season in an endeavor to do so. At present there is no known fungicidal treatment, nor are there any varieties of wheat recognised as resistant or immune.

DISEASES OF ORCHARD PLANTS.

Among the more common fungus pests of orchard trees are *Exoascus deformans*, *Venturia pomii*, and *Puccinia pruni*. The last seldom is of serious importance since it does not appear to any extent till late in the season. *Venturia pomii* may do serious damage in seasons when rain falls late in the spring, and the spraying operations are interfered with. Various "shot-hole" fungi cause damage to peach, apricot, almond, plum, and cherry trees. Of these, *Clasterosporium carpophyllum* and *Phyllosticta prunicola* are probably

the most common. In those seasons where the spring rains fall late the damage becomes more serious owing to the infection of the fruits. The foliage of trees, especially of some varieties, may be riddled with holes and the fruit disfigured and stunted owing to the presence of scabbed areas upon it. Passing reference must also be made to the "bitter-pit" disease of pomaceous fruits, which is at present under investigation by a Commonwealth expert.

DISEASES OF ROOT CROPS.

Potatoes are the only root crop of importance in South Australia, and they can only be grown successfully in certain areas about Adelaide, Mount Compass, and the South-East. Since 1909 *Phytophthora infestans* has been recorded. Owing to the dry climatic conditions that prevail during the potato-growing months, *Phytophthora* rarely is seen causing the rot of potato haulms and leaves as in Britain, but the well-known sunken brown areas on the tubers are extremely common. Sufficient experimental work under Australian conditions has not yet been performed to determine whether infection of the new tubers is by migration of the "hibernating" mycelium or by direct infection of the new tuber by means of spores from the outside, as Pethybridge maintains.

Potato growers in many parts of the State have their crops seriously damaged by "scab," many of the tubers being so disfigured by corky patches as to be almost unmarketable. Frequently eel-worms (*Heterodera radicicola*) appear to be the primary cause of the injury. Sclerotia of *Rhizoctonia* are common, but any active rot caused by the fungus has not been notified. Often the damage to the tubers is not clearly attributable to either of the above causes, and it may be that *Oospora scabies* is the active agent in these cases, as it appears to be in the United States. McAlpine states, on the other hand, that he has not observed any cases that can be attributed with certainty to this fungus. Scab of potatoes from whatever cause is a serious problem to many growers, since they are at a disadvantage because of the limited amount of ground suited to their purpose. This lack of ground often tends to over-cropping, with its attendant evil of spreading any pest which may be in the soil. It is to be hoped that the quarantine regulations that are in force will continue to prevent the introduction of such diseases as those caused by *Synchytrium* or *Sporogospora*, either of which would be exceedingly difficult to combat (if once established) owing to the special conditions obtaining here.

TRADE AND COMMERCE.

THE trade and commerce of South Australia has been continuous and substantial. Seventy-five years after the proclamation there was a population of 430,090 persons ; a public revenue of £4,450,739 ; a combined annual trade, imports and exports (oversea), equal to £16,588,758 ; 1,939 $\frac{1}{2}$ miles of railway had been built ; 19,861 miles of telegraph and 17,146 miles of telephone wires employed ; 4,340,435 acres of land cultivated ; 22,382 acres under vines ; over 6,171,907 sheep, 393,566 cattle, and 259,719 horses in the State ; whilst the export trade (oversea only), amounts to £9,615,279.

Even such a record of industrial expansion does not convey an adequate idea of the work accomplished in colonising and developing so vast a territory.

In 1841 there was a deficiency in the accounts of nearly £300,000, and bills drawn by Governor Gawler upon the Imperial Government were dishonored. The effect of this was to stop all public works, dislocate trade, and throw a number of persons out of employment. At a special meeting of the Adelaide Chamber of Commerce, held on April 28th, 1841, the following resolution was unanimously carried :—“ That this meeting regards the present financial position of the colony, arising from the dishonor of the bills drawn by His Excellency Colonel Gawler on the Colonisation Commissioners, with the deepest regret, and at the same time expresses the fullest conviction that these bills will be eventually paid ; that, confident in the stability and resources of the colony, this meeting is persuaded that the pressure resulting from these circumstances, and that which may be anticipated from the diminution of the current expenditure, will be but of temporary duration, provided that mutual confidence and forbearance be exercised by the commercial community.” The chamber further resolved that should the Governor see fit to draw on the Treasury they would accept such bills in payment of their ordinary business transactions.

The check was not of long duration, for a few years later discoveries were made of rich copper deposits, and the new settlement began to forge ahead on the high road toward prosperity. Within a very little time the public income was more than sufficient to cover all outgoings. In three years the revenue more than doubled itself. The pastoral industry was rapidly expanding, agriculture was extending, mining was in a buoyant condition.

The forties provided a copper boom, the fifties were known as the golden decade. The population having exceeded the prescribed limit fixed by the Imperial Act, the first Constitution Bill was passed, and a Parliament, consisting of two chambers, established. At about the same time railways connecting Adelaide with Port Adelaide, also with Gawler and Kapunda, were begun, and the first telegraph line was erected. The extension of the telegraph went on apace, and within three years from that time wires were stretched between Adelaide and Melbourne. The ten-year period ending with 1859 was an important one in the history of the province, and progress from 1836 to that time, though spasmodic, was considerable, as is shown by the following comparisons :—

Year.	Population	Land under Cultivation.	Revenue.	Total Trade.	Total Shipping.		
				Acres.	£	£	Tons.
1836	546	—	—	—	—	—	—
1840	14,600	2,687	30,618	335,436	83,787	—	—
1845	21,759	26,218	32,433	333,278	26,558	—	—
1850	63,700	64,728	238,983	1,416,389	174,000	—	—
1855	96,982	140,000	453,641	2,359,153	226,000	—	—
1859	122,735	361,884	511,927	3,163,370	216,000	—	—

The sixties provide one of the brightest chapters in the history of South Australia. In opening Parliament in 1864, the then Governor was able to make this official pronouncement—"I believe I am warranted in saying that at no other period of the colony's history have we had greater evidence of substantial prosperity." It was a period of great activity, of splendid achievements on the part of explorers, and glorious triumphs in the work of developing natural resources. Rich copper deposits were again discovered, this time on the northern end of Yorke's Peninsula. By 1864 exports of staple produce had reached an annual value of £3,000,000, or over £20 per head of the population—a splendid achievement for a handful of people to accomplish within a period of 28 years. Shipments of cereal products amounted in that year to £1,464,000; wool contributed £775,000; metals and minerals, £691,000. In an official report dealing with trade in 1864 it was stated—"Agricultural, pastoral, and mineral produce formed, as usual, the great bulk of the year's exports, and wool and copper were shipped in quantities of nearly equal value; but the breadstuffs exported were worth as much as the pastoral and mineral produce put together. This was, however, the result of exceptional circumstances, the value of cereal produce usually averaging from 10 per cent. to 15 per cent. higher than that of the other two staples. In fact, comparing the average yearly exports of each class during the past

five years with the averages for the preceding similar period, it will be found that the shipments by agriculturists bore a less percentage to the value of the total exports during 1860-64 than in the years 1855-59. For instance, in the two periods, breadstuffs, &c., have decreased from 39.3 per cent. to 38.8 per cent. of the total exports of produce; minerals from 27.1 per cent. to 25.7 per cent.; and, on the other hand, wool has increased from 31.5 per cent. to 31.8 per cent."

The population increased from 124,112 in 1860 to 181,146 by the end of 1869, and the public revenue rose from £438,827 to £777,351 in the same period. In 1865, income exceeded a million sterling. Agricultural expansion was of steady growth. In 1860 the cultivated area was 428,816 acres, by 1869 the acreage tilled had risen to 850,576 acres. At the end of that year the total trade turnover was valued at £5,747,805. There were 4,436,000 sheep, 119,000 cattle, and 73,000 horses in the colony. Staple produce exported was valued at £2,722,438.

This forward movement was well maintained during the next decade. The industrial expansion, though less sensational in the seventies, was substantial, and in other directions some remarkable work was accomplished. In the face of numerous difficulties, and at great expense, the province—then comprising less than 200,000 inhabitants—ran a telegraph wire through the heart of the continent, a distance of 2,000 miles. The cost exceeded half a million.

Trade steadily improved, until combined exports and imports reached an annual value of £17,000,000 in 1870. Staple produce worth £4,670,000 was sent away to oversea customers in 1888. Total acreage under cultivation rose to 2,864,000 acres in 1889, in which year 1,610 miles of railway were open to traffic. In 1887, the aggregate value of imports had reached a total of £119,644,000, while exports amounted to a total of £102,000,000. Toward this latter sum shipments of wheat and flour contributed £36,000,000; other agricultural produce, £1,300,000; wool, £29,000,000; and copper, £19,000,000. At the end of 50 years of colonising efforts 1,950,000 acres were under wheat, 360,000 utilised for hay, and 610,000 acres were devoted to other crops. The sheep in the province mustered 6,700,000; cattle, 389,000; and horses, 168,000.

The eighties witnessed one of the most important industrial developments in the history of South Australia. Valuable mineral deposits were discovered near the border of the province (Broken Hill in New South Wales) which led to a remarkable improvement in trade and exercised far-reaching influence. There was a growth in the general trade of South Australia during the period 1881-91 which can only be characterised as "marvellous." Mr. Coghlan,

when Government Statist of New South Wales, drew special attention to the "marked impetus," and said that South Australian trade in 1891 represented a trade of £61 3s. 4d. per inhabitant, "being almost without parallel in any important country." By 1890 the population had grown to 314,195 inhabitants, the public revenue reached £2,557,732, total land under cultivation stood at 2,649,098 acres, total trade amounted to £17,090,051, exports of staple produce had risen to £4,410,062.

The last decade of the century proved disastrous in many directions for the whole of Australia, and South Australia suffered in common with its neighbors. Early in the nineties financial troubles began to appear on the surface, and the year 1893 witnessed the suspension of several banks. The seasons were unfavorable, and the rainfall was below the average. South Australia came through the crisis remarkably well, and, considering the severity of the drought, production was well maintained.

The seventh decade opened full of promise. Confidence was restored in financial and commercial circles and trade improved.



Bagging Wheat from Harvester.

SEVENTY YEARS OF INDUSTRIAL PROGRESS.

Wool and wheat have been the two great staple products from the first. In later years wine has come rapidly to the front. Fluctuation in market

prices reduced the monetary returns in recent years, but a diminution in the cost of production has helped to compensate the grower. The following figures show exports since 1840:—

	Year.						Wool.	Breadstuffs.	Wine.
							£	£	£
1840	8,740	—	—
1850	131,731	38,312	—
1860	573,977	499,102	1,430
1870	902,696	470,828	12,097
1880	1,716,171	2,469,720	8,481
1890	1,353,762	2,018,719	50,738
1900	1,003,391	863,463	78,153
*1910	1,943,455	4,404,664	48,414
*1911	1,933,379	3,844,681	66,617
*1912	2,032,383	3,245,289	53,763

* Oversea only.

The bulk of the trade in wine is "Inter-State" for which export figures have not been available since 1909.

In minerals copper has easily led—

PRODUCTION.

Year.	Copper.	Minerals— Total Value of.	Year.	Copper.	Minerals— Total Value of.
	£	£		£	£
1840	—	—	1890 ..	226,992	284,893
1850	353,890	365,464	1900 ..	394,446	448,289
1860	420,905	446,537	1910 ..	306,120	406,942
1870	568,780	574,090	1911 ..	332,500	438,951
1880	346,174	347,246	1912 ..	461,500	584,478

The number of sheep, cattle, and horses in the State at the periods named is shown as under—

	Year.						Sheep.	Cattle.	Horses.
1840	200,160	15,100	1,060
1850	984,199	60,034	6,488
1860	2,824,811	278,265	49,399
1870	4,400,655	136,832	83,744
1880	6,463,897	307,177	157,915
1890	7,004,642	359,938	187,688
1900	5,235,220	214,761	166,790
1910	6,267,477	384,862	249,326
1911	6,171,907	393,566	259,719
1912	5,481,489	383,418	276,539

South Australians have always enjoyed a high reputation as traders. On a *per capita* basis of comparison there are few countries in the world that have a better trading record than South Australia. The following statement is an instructive comparison—one which bears eloquent testimony to the progress and prosperity of the State :—

Year.	VALUE OF IMPORTS.			VALUE OF EXPORTS.				
	Total.	Per Inhabitant.		Total.	Per Inhabitant.			
		£	s.	d.	£	s.	d.	
1840	303,357	20	15	6	32,097	2	5	3
1850	845,572	13	5	5	570,817	8	19	2
1860	1,639,591	13	4	1	1,783,716	14	7	4
1870	2,029,793	11	1	11	2,419,488	13	4	8
1880	5,581,497	20	17	8	5,574,505	20	17	2
1890	8,262,673	26	10	1	8,827,378	28	6	4
1900	8,034,552	22	11	7	8,029,157	22	11	3
*1910	5,976,543	14	18	0	10,243,197	25	10	9
* 911	6,245,840	15	5	9	10,174,966	24	18	1
*1912	6,973,479	16	10	9	9,615,279	22	16	1

* Oversea only.

The expansion of the export trade in articles the produce of the State is an inspiring record—

Year.	Staple Exports.	Average per Head of Population.	Year.	Staple Exports.	Average per Head of Population.				
						£	£	s.	d.
1838	5,040	0 16 10	1875 ..	4,442,100	21 11 0				
1839	9,165	0 18 4	1880 ..	4,829,577	18 0 11				
1840	15,650	1 1 5	1885 ..	4,385,599	14 6 5				
1845	131,800	6 1 2	1890 ..	4,410,062	14 0 8				
1850	545,040	8 11 2	1900 ..	3,610,517	10 2 2				
1855	686,953	7 1 8	1910 ..	7,712,830	19 4 7				
1860	1,576,326	12 18 6	1911 ..	6,946,206	17 0 0				
1865	2,574,657	17 11 9	1912 ..	Not recorded	separately.				
1870	2,123,297	11 11 0							

The value of “ total trade per head ” stood for South Australia at £35 9s. 10d. in 1881 ; £64 3s. 4d.—the highest for Australasia—in 1891 ; and £42 19s. 7d. in 1901. On a *per capita* basis of comparison ranks second highest among the States for exports of staple produce and total trading.

The growing trade of the State required the services of a large fleet of ships, and in no direction has there been a more remarkable evolution than in the class of vessels trading to South Australian ports. The number and tonnage of vessels entering and leaving South Australian ports is set out below:—

Year.	Number of Vessels.	Tonnage.	Year.	Number of Vessels.	Tonnage.
1840	425	83,787	1890 ..	2,122	2,190,442
1850	559	174,455	1900 ..	2,013	3,552,636
1860	662	209,036	1910 ..	2,610	7,090,748
1870	916	287,989	1911 ..	2,611	7,252,376
1880	2,156	1,200,904	1912 ..	2,417	7,322,593

IMPORTS AND EXPORTS.

The following shows the import and export trade of the State and will show at a glance the increasing turnover:—

Year.	Total Trade.	IMPORTS.			EXPORTS.		
		Inter-State.	Oversea.	Total.	Inter-State.	Oversea.	Total.
	£	£	£	£	£	£	£
1838	165,024	—	—	158,582	—	—	6,442
1840	335,436	—	—	303,357	—	—	32,079
1850	1,416,389	—	—	845,572	—	—	570,817
1860	3,423,307	526,366	1,113,225	1,639,591	910,744	872,972	1,783,716
1870	4,449,281	625,941	1,403,852	2,029,793	1,039,270	1,380,218	2,419,488
1880	11,156,002	1,928,509	3,652,988	5,581,497	1,166,795	4,407,710	5,574,505
1890	17,090,051	4,753,806	3,508,867	8,262,673	3,501,268	5,326,110	8,827,378
1900	16,063,709	4,145,609	3,888,943	8,034,552	3,892,720	4,136,437	8,029,157
1901	15,387,477	3,444,382	3,927,206	7,371,588	3,583,111	4,332,778	8,015,889
1902	13,772,296	2,948,088	3,125,094	6,073,782	3,967,897	3,730,617	7,698,514
1903	14,919,072	3,443,869	3,174,758	6,618,627	4,707,821	3,592,624	8,300,445
1904	16,115,716	4,161,038	3,289,678	7,450,716	3,955,555	4,709,445	8,665,000
1905	17,930,276	5,207,005	3,232,604	8,439,609	4,688,029	5,402,638	9,490,667
1906	21,635,435	5,719,547	3,982,717	9,702,264	5,062,272	6,870,899	11,933,171
1907	26,018,637	7,304,593	4,815,459	12,120,052	5,928,038	7,970,547	13,898,585
1908	25,010,004	6,259,480	4,971,990	11,231,470	6,111,237	7,667,297	13,778,534
1909	23,982,370	6,239,267	5,096,402	11,335,669	4,177,986	8,468,715	12,646,701
1910*	16,219,740	Record ceased	5,976,543	5,976,543	Record ceased	10,243,197	10,243,197
1911*	16,420,806	Record ceased	6,245,840	6,245,840	Record ceased	10,174,966	10,174,966
1912*	16,588,758	Record ceased	6,973,479	6,973,479	Record ceased	9,615,279	9,615,279

* Oversea only.

TRADE PER INHABITANT.

The following return shows the total value of trade—in ports and exports—and value per inhabitant decennially from 1860-1900 and for each year from 1907 to 1912 :—

Year.	Total Trade.		Imports.		Total Exports.		Staple Exports.		Mean Population.
	Total Value.	Per Head.	Total Value.	Per Head.	Total Value.	Per Head.	Total Value.	Per Head.	
	£	£ s. d.	£	£ s. d.	£	£ s. d.	£	£ s. d.	
1860	3,423,307	27 11 5	1,639,591	12 4 1	1,783,716	14 7 4	1,576,326	13 13 11	124,159
1870	4,449,281	24 6 7	2,029,793	11 1 11	2,419,488	13 4 8	2,123,297	11 12 3	182,876
1880	11,156,002	41 14 10	5,581,497	20 17 8	5,574,505	20 17 2	4,829,577	18 1 4	267,273
1890	17,090,051	54 16 5	8,262,673	26 10 1	8,827,378	28 6 4	4,410,062	14 2 10	311,730
1900	16,063,709	45 2 10	8,034,552	22 11 7	8,029,157	22 11 3	3,610,517	10 2 11	355,857
1907*	26,018,637	70 0 8	12,120,052	32 12 6	13,898,585	37 8 2	8,802,038	23 13 10	371,532
1908*	25,010,004	65 10 8	11,231,470	29 8 7	13,778,534	36 2 1	8,551,351	22 8 2	381,649
1909*	23,982,370	61 3 8	11,335,669	28 18 4	12,648,701	32 5 4	8,845,483	22 11 4	391,977
+1910*	16,219,740	40 8 9	5,976,543	14 18 0	10,243,197	25 10 9	7,712,830	19 4 7	401,103
+1911	16,420,806	40 3 10	6,245,840	15 5 9	10,174,966	21 18 1	6,946,206	17 0 0	408,558
+1912	16,588,758	39 6 10	6,973,479	16 10 9	9,615,279	22 16 1	Not recorded separately.		

* Including Northern Territory.

+ Overseas only.



Shipping Wheat, Port Adelaide.

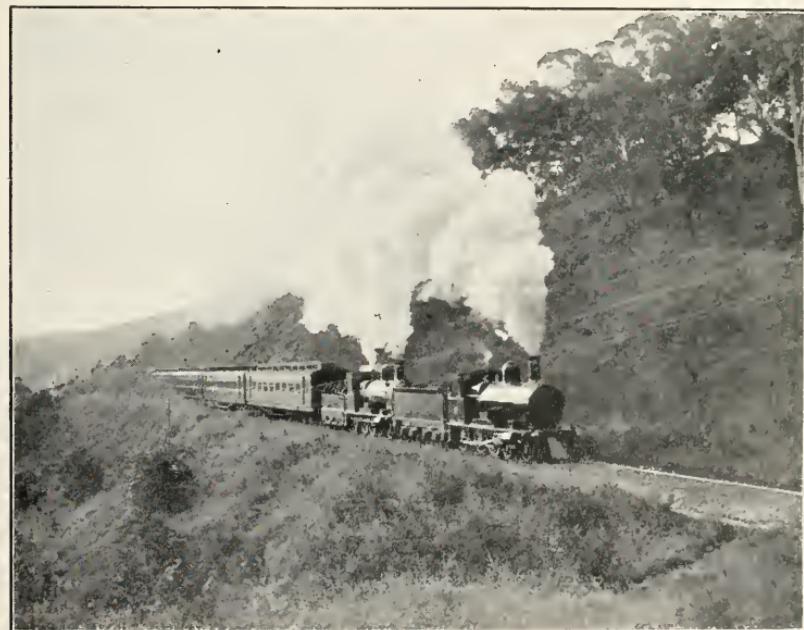
RAILWAYS AND TRAMWAYS.

—o—

RAILWAYS.

THE railway systems are all State owned and State controlled, except the railway between Port Augusta and Oodnadatta (478 miles, 3ft. 6in. gauge) which was transferred to the Commonwealth, but was subsequently worked under agreement with the Commonwealth Government, by the South Australian Railways Commissioner, as from January 1st, 1911. To South Australia belongs the honor of having put down the first railway track in Australia and built the first State-owned railway in the British Empire. The first line of rails actually laid down was between Goolwa and Port Elliot. It was six and a quarter miles in length, was opened in May, 1854, and initiated rail communication, not only in this State, but in Australasia. In September of the same year the Goolwa railway was operated by horse traction and conveyed passengers as well as freight. The line was constructed and worked by a private company. In August, 1864, the line was extended to Victor Harbor, and subsequently incorporated in the State railways. In 1848 a company was formed, and legislative authority obtained two years later, for the construction of a railway from Adelaide to Port Adelaide. The Government reserved the right to purchase the line, and a limitation was placed upon the grant of lands. Negotiations were suspended, and the Legislature came forward with a guarantee of 5 per cent. for 10 years on the estimated cost of construction. The company promoters were not satisfied, and the Government stepped in and did the work; thus laying the foundation for the extensive system of State-owned railways in Australia. It was not until April, 1856, that the seven and a half miles of track connecting Adelaide and Port Adelaide was opened, as the result of an expenditure of over £25,000 per mile. Platelayer and bridge-builder then began to work in earnest in South Australia. They turned their faces northward. The first section was 25 miles, to Gawler. That line was opened in 1857, and the little province owned at the end of that year $11\frac{1}{2}$ miles of railway. The next step was to Kapunda, where copper had been discovered. The north-eastern section was available in 1860, and for many years Kapunda remained a terminus, and was greatly frequented by northern settlers when visiting the city or returning to their homes. For 10 years it represented the "outpost" of the railway system, but in 1870 the Burra was connected. The opening up of the Northern Areas a few years later took the railway to Crystal Brook and Port Pirie. The northward movement steadily continued, until Port Augusta,

260 miles from Adelaide, was connected. Two engineering feats in connection with railway-building in South Australia were the construction of the great northern system, which has its terminus at Oodnadatta, and the line through the Mount Lofty Range, across the River Murray, connecting with the inter-State system, which now extends to Longreach in Queensland—3,301 miles from Oodnadatta. The mountain ranges between Quorn and Port Augusta—in which is situated the bold and strikingly grand Piehi Riechi Pass—tested the skill of the engineers. Greater difficulties were experienced in finding a passage through the Mount Lofty Range. Nine tunnels, aggregating a total length of nearly 2,000yds., and a wrought-iron viaduct, 620ft. long and 108ft. high, were necessary in the first 30 miles. To cross the River Murray a bridge, consisting of five 120ft. spans—each containing 140 tons of ironwork—and 23 spans, each 60ft. long, across a swamp, had to be built.



Inter-State Express in Mount Lofty Ranges.

From south to north these railways extend for over 1,000 miles. The total railway mileage open for traffic on June 30th, 1913, was $2,167\frac{3}{4}$ (inclusive of the Port Augusta to Oodnadatta Railway).

There are two gauges in the railway systems of the State—5ft. 3in. and 3ft. 6in. The question of bringing about uniform railway gauge for the whole of Australia is under consideration.

COMPARATIVE STATEMENT SHOWING WORKING RESULTS.

Year ended June 30th,	Miles Open at end of Year,	Capital Cost Average Miles Open.				Per cent. to Gross Revenue.	NET REVENUE.	
			Earnings,	Working Expenses, Amount.	Amount.		Amount.	Percentage on Capital Cost.
1888.....	1,500	9,395,533	883,713	432,274	48·92	451,439	4·80	
1890	1,610 $\frac{1}{4}$	10,234,749	1,043,878	529,005	50·68	514,874	5·03	
1895	1,722	12,520,378	960,155	568,973	59·26	391,182	3·12	
1900....	1,736 $\frac{1}{4}$	13,014,428	1,166,987	657,841	56·37	509,146	3·91	
1906	1,745 $\frac{3}{4}$	13,610,520	1,349,765	764,385	56·63	585,380	4·30	
1907	1,832 $\frac{1}{4}$	13,699,029	1,575,368	868,005	55·10	707,363	5·16	
1908	1,879 $\frac{1}{4}$	13,858,699	1,741,259	969,530	55·68	771,729	5·57	
1909	1,888	14,157,245	1,639,259	940,828	57·39	698,431	4·93	
1910....	1,912 $\frac{1}{4}$	14,352,602	1,840,399	1,069,140	58·09	771,259	5·37	
1911.....	1,475 $\frac{1}{2}$	13,644,155	2,015,182	1,222,439	60·66	792,743	5·81	
1912.....	1,461 $\frac{1}{2}$	13,240,175	2,090,563	1,293,987	61·89	796,576	6·02	
1913.....	1,689 $\frac{3}{4}$	14,178,485	2,222,436	1,393,775	62·71	828,661	5·84	

The railways have paid interest on the capital expended on them since their inception, together with working expenses, and on the 30th June, 1913, had a credit balance of £262,101. As a number of the railways built have been largely of a developmental nature the result attained is exceedingly creditable.

The year 1887 was the last year in which the State railways were under direct Ministerial supervision and control. In the year 1888 the railways were placed under the administration of a board of three Commissioners, who continued in office until 1895, since when the railways have been under the control of one Commissioner, who is aided by a board consisting of the General Traffic Manager, the Chief Engineer, and the Chief Mechanical Engineer.

Two projects of the Commonwealth are before the public at the present time for bridging the continent with railways—northward to connect with the Pine Creek railway, and westward from Port Augusta to join the West Australian line at Kalgoorlie. The latter line is now in course of construction. The estimated cost of constructing the line (4ft. 8 $\frac{1}{2}$ in. gauge) is, approximately, £4,000,000. The distance to be covered is 1,063 miles.

For some time past it has been proposed to extend the great northern system of railways—the terminus of which is situated at Oodnadatta, 688 miles from Adelaide—to Pine Creek, the terminal point of the railways in the Northern

Territory. In accordance with The Northern Territory Surrender Act, 1907 (State Act), and the Northern Territory Acceptance Act, 1910 (Commonwealth Act), the railway from Port Augusta to Oodnadatta was transferred to the Commonwealth on January 1st, 1911, but is at present worked for the Commonwealth authorities by the State Railways Commissioner. The last Act mentioned ratified and approved the agreement under which the Northern Territory was transferred to the Commonwealth from the State of South Australia, and also provided for the transfer of the Palmerston and Pine Creek railway.

The Railway Department has a fine record, very few accidents having occurred during more than half a century of working. In his annual report, the Commissioner has been able to state—"Notwithstanding the fact that the traffic during the year just closed was the heaviest ever known on the railways, there was not one serious accident to a passenger for which the department could be held to blame."

Splendidly-equipped workshops have been established at various centres. From the main works at Islington, a few miles from Adelaide, locomotives, carriages, and wagon stock are constructed.

There are, approximately, 8,754 hands employed by the Railway Department.

TRAMWAYS.

It was in 1876 that the first Tramways Act relating to Adelaide became law, and the urgent need for means of transit resulted in a steady growth of horse tramways operated by several companies. In 1906 the Government agreed to purchase all the tramways for the sum of £284,000, and passed an Act to authorise the Government to purchase certain tramways and for the creation of a Municipal Tramways Trust to construct and work tramways and for other purposes, under which provision was made for all the said tramways to be vested in a Municipal Tramways Trust. In 1912 the Government passed an Act to add the Corporation of the City of Port Adelaide to the local authorities interested in the Trust.

THE SYSTEM.

The system adopted was the overhead trolley system, the power being conveyed from the power station at Port Adelaide by overhead cables at a pressure of 11,000 volts to the terminal house at North Adelaide, at which point it is conveyed underground to No. 1 converter station on East Terrace. From the junction house at Croydon a branch line runs to No. 2 converter station at Torrensville, and provision is made for extensions to the Government Workshops at Islington.

CAR DEPOT.

The main car depot, accommodation block and administrative building workshops, paint store, general store, emergency house, permanent way depot, &c., are concentrated on one site covering an area of nine acres about one mile from the centre of the city on the outer boundary of the park lands with an entrance from Hackney Road. On account of the administrative building being situated as above, a great saving in time has resulted, by the concentration of departments and officers in one place. In addition to the usual fire-hose equipments, the whole of the buildings in the main car depot are equipped with the Grinnell automatic sprinkler, and chemical fire extinguishers, and every possible device for saving labor has been adopted. In close proximity are the necessary offices for the ordinary running work, such as marshals' room, inspectors' and examiners' room, motormen and conductors' room, traffic staff lavatory, clubroom, machine-room, running-store, running-staff messroom, &c., and everything is done to provide for the comfort of the men.

WORKSHOP AND STORES.

At the rear of the car depot are the workshops, which consist of a paint shop, car-building shop, electrical shop, machine shop, truck shop, and smithy, all of which are provided with the most up-to-date machinery. In close proximity are the general stores, and some distance away the oil and paint store, this latter being absolutely fireproof. Within the depot grounds there are two five-room cottages for the use of the depot master and the overhead foreman in order that they may be always available; an emergency house with provision for the storage of two-horse tower wagons with stalls for the necessary horses, and a garage for the motor tower wagons.

THE EMPLOYES.

One of the most interesting features of the undertaking is the Adelaide Electric Tramways Club, which, by resolution of the men themselves, has been made compulsory for all permanent men in the service to join who have attained the age of 19 years. The funds of the club consist of—(1) General fund; (2) Sick, accident, and funeral fund.

The subscription is 3d. per member per fortnight to the general fund, and 6d. per member per fortnight to the sick, accident, and funeral fund, and each of these subscriptions is subsidised £1 for £1 by the Trust. The sick, accident, and funeral fund is strictly earmarked for the purposes indicated by its title; and the general fund is applied to the general benefit of the members. The clubroom has been provided and furnished by the Trust,

the furniture, including three billiard-tables, piano, cardtables, reading-tables, &c., the principle, broadly, being that the Trust provides the furniture, the charges thereon and the cost of maintenance being borne by the club. In addition to the clubroom, the general fund is utilised for subsidising where necessary a large number of subsidiary recreation clubs, a rifle club, which has the use of a miniature rifle range on the premises ; a house and social committee, which attends to social entertainments ; a quoit club, which has the use of a quoit ground on the premises ; and a library, which is housed in the clubroom.



His Majesty's Mail in Central Australia.

SHIPPING.

SEVENTY years of shipping progress is shown in the following table of entries and clearances at South Australian ports :—

Year.	INWARDS AND OUTWARDS.					
	Total.		British.		Foreign.	
	No. Vessels.	Tons.	No. Vessels.	Tons.	No. Vessels.	Tons.
1840	425	83,787	394	75,086	31	8,701
1910	2,610	7,090,748	2,222	6,068,453	388	1,022,295
1911	2,611	7,252,276	2,237	6,221,836	374	1,030,440
1912	2,417	7,322,593	1,936	5,885,478	481	1,437,115

The most significant change in the shipping industry was the superseding of sail power by steam. The bulk of South Australia's oversea traffic is now conducted by large steamers, and these almost invariably bring cargo for more than one State. Consequently their stay in port is only a fraction of the time which used to be spent by the old style traders which ran direct between Port Adelaide and the United Kingdom.

The first steam communication between England and South Australia was opened in 1852, *via* the Cape of Good Hope. The service did not last long. The same year, however, a branch line was established by the P. & O. Company between Singapore and Australia. In 1857 the need of an improved connection with the outside world was felt. The Chamber of Commerce, in a petition to Parliament, expressed the opinion that direct steam communication with Great Britain, combined with emigration and a postal service, would prove highly advantageous. The opening of the Suez Canal now effected a complete revolution in ocean traffic between Europe and Australia. Branch lines became trunk services, and South Australia occupied a more prominent part in the timetable of ocean steamers.

THE INTER-STATE SERVICE.

The inter-State shipping business furnishes a picturesque chapter in South Australian history. Until the building of the Adelaide-Melbourne railway, water carriage was the only means of maintaining relations with the other settled portions of the island continent. The bulk of the goods traffic between the States is still carried on by sea, the proportion being over 60 per cent. of the carrying trade of each portion of the mainland. In 1847 no fewer than 115 ships out of 150 arriving in South Australia came from British colonies. The discovery of gold in Victoria in the fifties led to a rush for berths on every available craft which could be pressed into service. The inter-State service includes steamers of over 7,000 tons and over 400ft. in length, and these come into the inner harbor.

The shipping trade has always occupied and must retain an important position in the development of South Australia. It cannot be otherwise with a producing country of extended coastline situated thousands of miles from the chief markets of the world. Notwithstanding a splendid inter-State railway system, the bulk of the produce exchanged with other parts of the island continent is transported by water. South Australia has 2,000 miles of coastline within her own borders, thus making necessary the employment of a large fleet of coasting vessels. The development in the maritime branch of industry within the short period of the State's existence has been no less marvellous than in other directions, and the achievements are as worthy of being recorded, even though they form part of a world-wide movement. Especially is this true of the bringing into existence of a distinctly Australian mercantile marine, in which South Australian enterprise and capital have played an important part. The history of South Australian shipping is the record of the rise and development of long-distance steam communication by water.

INNER HARBOR ACCOMMODATION.

South Australia has participated in the benefits arising from the increase in the size of ships during the past 50 years. Of 102 vessels which arrived in 1858, the largest was 600 tons, and for many years the greater number fell beneath 1,000 tons. Of 315 arrivals in 1868, only one exceeded 1,100 tons, while in 1878 the limit was 2,700 tons. Ten years later no fewer than 40 vessels which reported in South Australia were from 3,000 to 3,500 tons register. Now the majority of merchantmen calling here are of mammoth proportions. The construction of a first-class harbor at the chief ports of the State has been effected by the outlay of a large sum of money.

THE OUTER HARBOR.

In 1901 a Bill was passed through Parliament authorising the construction of an outer harbor, subject to a favorable report by a board of expert engineers. This report having been obtained, a contract was let for the construction of the work, but difficulties were experienced in carrying out details, and it was not until January 16th, 1908, that the harbor was declared open to the shipping of the world. There is ample accommodation for the largest steamer visiting Australia to berth in perfect safety alongside the wharf. January 16th, 1914, will mark the completion of the sixth year of active work at the Outer Harbor, and it may not be out of place to draw attention to the rapid growth of its trade and the favor in which it is



Outer Harbor, Port Adelaide.

held by both shipmasters and the public. Commencing with vessels of the Orient Mail line only, the wharf is now regularly used by the P. & O. Mail line, the Nord-Deutscher Lloyd, the Shire line, the Blue Funnel line, the P. & O. Branch Service, and has also been used by the White Star line, including the *Ceramic* of 18,500 tons, for which there was ample depth of water. In 1908 69 vessels berthed at the harbor, their gross tonnage equalling 497,828 tons. In 1912 251 vessels, with a gross tonnage of 2,006,502 tons were berthed. The wharf now has a completed frontage of 2,200ft. The entrance channel is 400ft. wide, and there is a swinging berth 3,000ft. in length by

1,126ft. wide. The depth of water in the entrance channel, swinging berth, and alongside wharf is 33ft. L.W.S. throughout. The railway has been extended from Largs Bay, and a commodious railway station is in close proximity to the wharf. Post and telegraph office, refreshment rooms, commodious Customs sheds, and all necessary facilities for handling and disposal of cargo are provided. An up-to-date acetylene gas plant has been installed for the efficient lighting of wharf and railway. The Railway Department have provided a convenient service of trains for the benefit of passengers *en route* by the mail steamers who may desire to visit Adelaide, or go overland to the Eastern States. In view of the increased demand for space by ocean steamers using the Outer Harbor, the wharves are now being further extended for another 1,000ft., in addition to which a revetment mound is completed on the northern side of harbor, which effectively breaks the force of the range brought up at high tides by strong north and north-west winds.

THE LIGHTHOUSE SERVICE.

The coastline of South Australia is remarkably well lighted, especially considering the comparatively short time that the State has been established. The earliest guiding beacon set up was exhibited from the masthead of an old vessel moored outside the entrance to the Port Adelaide River. This light was first shown on July 17th, 1840, and it was 12 years later before a permanent mark was erected. Lighthouse construction dates from 1852, when a revolving light on Cape Willoughby, situated on the eastern extremity of Kangaroo Island, was set up. Thenceforward, as trade increased, and, unfortunately, in some instances as disastrous wrecks demonstrated the necessity, fine lighthouses were constructed around the shores of the State.

HARBOR BOARD.

A Bill was passed in the last Session of Parliament providing for the purchase of all wharves and river frontages at Ports Adelaide and Pirie which are now privately owned, provision is also made for the appointment of a board which will exercise control over these properties, together with all Government wharves and jetties throughout the State, and will assume such duties and responsibilities formerly exercised by the Marine Board, which are not transferred to the Commonwealth under the Commonwealth Navigation Act and the Lighthouses Act.

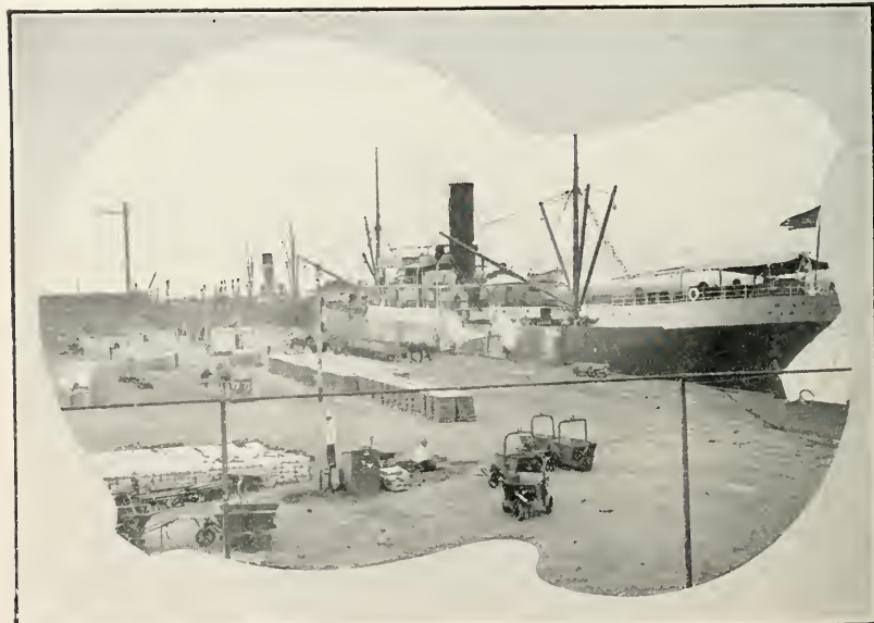
POR T DUES, WHARFAGE, AND PILOTAGE.

The large expenditure incurred by the Government in providing adequate lights and seamarks on the extended coastline, required the imposition of special dues to recoup some of the expense. Light dues were therefore

introduced, and were for many years collected for the above purpose. Of late, however, the funds so obtained have been used principally for the improvement of harbors, deepening, and similar purposes. Light dues were abolished during the year 1911 and Port dues introduced, and are now collected on all shipping trading in or visiting the State.

It should be mentioned in connection with this matter that the cost incurred by the Government on deepening and other improvements at Ports Adelaide and Pirie and elsewhere has been considerable, the expenditure approximating £2,000,000 sterling.

In addition to port dues, a charge is made on oversea ships for pilotage. If a vessel is registered in the Commonwealth the shipmaster is required to employ a pilot to bring his ship from the anchorage to the harbor, unless he has obtained an exemption certificate, the charges for pilotage ranging from a minimum of £2 10s. to a maximum of £12. At Port Adelaide the pilots are Government servants, the fees being paid into revenue.



Shipping Silver and Silver-lead Bullion, Port Pirie.

GEOLOGY AND PHYSIOGRAPHY.

BY WALTER HOWCHIN, *Lecturer in Geology and Palaeontology in the University of Adelaide.*

The main physiographical outlines of South Australia resolve themselves into three moderately distinct areas—A series of hilly ranges, having a north and south direction, occupy the middle portions of the State; on the western side there is a low plateau of sandy and calcareous soils with inliers of older rocks; and on the eastern side, extending from the River Murray to the eastern limits of the State, there are sandy and calcareous plains of Cainozoic age.

There is less diversity in the geology of South Australia than any other of the Australian States, but this is somewhat compensated for by the presence of some unique features. The following is a representation, in tabular form, of the principal geological horizons that occur within the limits of South Australia:—

CAINOZOIC	RECENT	Raised estuarine areas of the gulf, and raised sea bed of the South-East (fifth marine horizon). Flood plains of the newer river systems. Extinct marsupial and other remains in river gravels, probably dating from the newer Pleistocene.
	PLEISTOCENE . . .	Alluvial sands and gravels of the older river systems (often consolidated). Calcareous marine bed (fourth) either above or below sea level. Volcanic cones of the South-East. Elevation of peneplains, followed by their dissection.
	NEOGENE	(?Pliocene)—Third marine series, about 400ft. below sea level. (?Miocene)—Second marine series, at about present sea level.
	PALÆOGENE . . .	(?Oligocene or Eocene)—First marine series: thick beds of deep-water origin. Fluvatile sands and fine gravels, carbonaceous muds and lignite.

MESOZOIC	CRETACEOUS	<i>Upper</i> .—Desert sandstone (freshwater series). Porcelainized clays and chalcedonized sandstones, pipe-clays, gypseous clays, &c. <i>Lower</i> (marine series).—Mudstones, carbonaceous shales, and impure limestones.
	JURASSIC	<i>Leigh's Creek Series</i> (land and fresh-water).—Carbonaceous shales, brown coals, sandstones, ferruginous bands, with <i>Unio</i> and plant remains.
PALÆOZOIC	PERMO-CARBO-NIFEROUS	<i>Glacial</i> .—Polished and striated pavements, with morainic material, boulder clays, and glaciated erratics.
	ORDOVICIAN	<i>Larapintine Series</i> .—Sandstones, mudstones, and thin limestones with fossiliferous horizons.
	CAMBRIAN	<i>Upper</i> .—Purple slates, quartzites, and fossiliferous limestones. <i>Lower</i> .—Slates, phyllites, quartzites, and limestones. Glacial boulder clays, grits, and thin limestones, carrying striated erratics. Basal grits and conglomerates.
PROTEROZOIC	ALGONKIAN	Mica and talc schists, pegmatized schists, gneissic schists, siliceous and metamorphosed quartzites. The sediments are penetrated by syenitic, porphyritic, aplite, pegmatitic, and granitic dykes.

PROTEROZOIC (ALGONKIAN).

The non-fossiliferous character of the older rocks of South Australia made the determination of their geological age a matter of some difficulty. Mr. A. R. C. Selwyn, who, in 1859, made a hurried reconnaissance of the Mount Lofty and associated ranges, was inclined to think that the rocks seen by

him might be "grouped under three distinct and unconformable formations," and suggested that they might possibly represent beds of Cambrian, Silurian, and Devonian age.

The discovery of fossils in limestone on Yorke Peninsula in 1879 was the first step towards a scientific diagnosis of the age of the older rocks of this State. The fossils, which indicated a Cambrian fauna, occurred in beds that rested unconformably on an underlying series of a highly metamorphic character. The late Professor Ralph Tate regarded the rocks of the Mount Lofty Ranges (which are azoic and more or less altered) as of the same age as this older and crystalline series of Yorke Peninsula, which he defined as Archaean, and concluded that, with the exception of the fossiliferous beds referred to, and others of a like character afterwards discovered in the Flinders Ranges, all the older rocks of South Australia were of Archaean age. Later discoveries have shown that this determination was in error—much of Tate's "Archaean" must be classed as Cambrian.

The most extensive exposure of Pre-Cambrian rocks is on the western side of the State, forming a low plateau from which rise, in places, ranges of hills of moderate elevation, the older rocks of which are mostly of Pre-Cambrian age. The Gawler Ranges, consisting mainly of porphyry, form rounded knolls covering a large extent of country on the south side of the shallow lakes lying to the west of Lake Torrens. The Musgrave and other ranges near the Western Australian border are also of Pre-Cambrian age. This vast region (which includes much of Western Australia as well as South Australia) forms the geological axis of the continent and is the greatest exposure of rocks of this age to be found in Australia.

The Pre-Cambrians also outcrop in the Mount Lofty Ranges, forming the geological axis of these highlands. Their exposure is not continuous but occur at intervals as inliers of the Cambrian, following the general strike of these beds in a north-easterly direction. They can be advantageously studied on the north side of the Inman Valley, at Mount Compass, Aldgate, on the River Torrens near Castambul, in the South Para River, at Barossa Goldfield, Williamstown, and Tanunda Creek. They also form the geological axis of Yorke Peninsula, where they are covered, in places, by sediments of Upper Cambrian age.

The series cannot be subdivided. They consist, primarily, of highly altered sedimentary deposits in the form of slates, schists, quartzites, &c. The former are often interlaminated with fine layers of pegmatite that have been injected along the planes of schistosity. This is sometimes carried so far as to give the stone a gneissic character. Eruptive rocks, usually highly felspathoid, have a large development, chiefly as syenites, porphyries, aplites,

and other granitoid rocks. These are often so intermingled as to form an intricate complex. Basic igneous dykes sometimes occur, but they are much less frequent than those of an acid type. In northern Yorke Peninsula the Pre-Cambrians carry extensive deposits of copper, which have been mined at Moonta, Wallaroo, and Kadina for many years. Ilmenite, as a primary product, is also often present as granules, streaks, or veins.

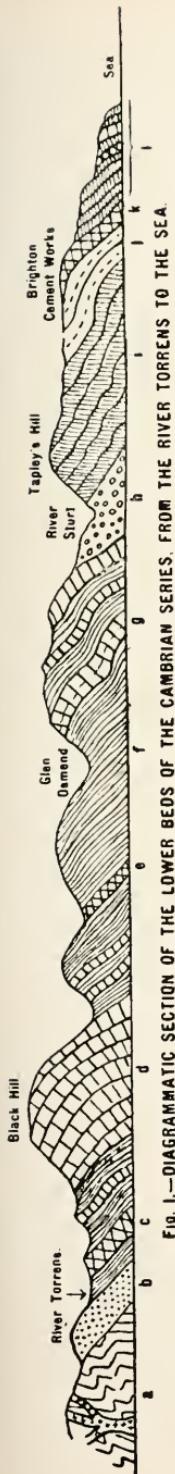
CAMBRIAN.

The Cambrian System of Australia has its greatest development within the limits of South Australia. The sediments were laid down in a great geosynclinal fold and, at a moderate estimate, are from 15,000ft. to 20,000ft. in thickness. The close of the Cambrian period was marked by a movement of elevation, accompanied by great pressure, that led to the formation of fold mountains which occupied most of the meridional-central portions of the State. The beds thinned out against the western Pre-Cambrian plateau, producing overlap with transgression, in that direction, extending over the site of the present Yorke Peninsula and the country on the western side of Lake Torrens. In an easterly direction the Cambrians extend across the State into New South Wales, where they form parts of the Barrier Ranges.

The Cambrian System of South Australia is divisible into a lower and an upper series. The evidence of stratigraphical unconformity is not very clear, but there is a marked difference in the two series with respect to their lithological characteristics, metamorphic condition, and the absence of fossils in the lower with their presence in the upper.

LOWER CAMBRIAN (FIG. 1).

The *Basal Beds* rest with a strong unconformity on a Pre-Cambrian floor. They usually consist of arkose sandstones and grits, often heavily charged with elastic ilmenite, laid down in the form of current bedding. In places basal conglomerates occur, consisting mainly of highly water-worn pebbles of quartz and a very siliceous quartzite. The beds have undergone severe thrusts and micro-faulting, features which are often beautifully seen in hand specimens. Mylonitic zones are common, and the passage of the siliceous pebbles into quartz veins, by flowage, can often be recognised. The unconformity of the Cambrian in relation to the older series can be well seen in the following localities:—ARDROSSAN, Yorke Peninsula, where fossiliferous limestones (Up. Camb.) and felspathoid grits, gently flexured, rest on vertical beds of Pre-Cambrian schists. ALDGATE, near Mount Lofty, where the basal beds are chiefly in the form of a white felspathoid freestone, and in a quarry



REFERENCES TO GEOLOGICAL HORIZONS.

- a Pre-Cambrian.
- b Basal Grits and Conglomerates.
- c The "Blue-Metal" Limestone.
- d The Thick (or River Torrens) Limestone.
- e The "Thick" (or Glen Osmond) Shale.
- f The "Glen Osmond and Mitcham" Quartzite.
- g The "Glen Osmond and Mitcham" Quartzite.
- h Glacial Beds.
- i Tapley's Hill Slates.
- j Impure Siliceous Limestones.
- k Brighton Limestone.
- l Purple Shales, Quartzites, etc.
- m The Thick Quartzite.
- n The Thick Quartzite.
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near the railway station, the rock takes the form of a breccia composed of angular fragments of Pre-Cambrian pegmatite. At COX'S CREEK, in the same neighborhood, a very coarse arkose grit and conglomerate, dipping at a low angle, rests on vertical Pre-Cambrian pegmatized schists. On the east side of INMAN VALLEY, about nine miles from Victor Harbor, the basal beds consist of a very coarse conglomerate, 150ft. in thickness, resting on a Pre-Cambrian complex. Towards the base of the Cambrian, in this outcrop, the pebbles are rolled out into flattened lenticles and horizontal quartz veins and the matrix becomes a flaky comminuted mass. Near WILLIAMSTOWN (Barossa District), the basal beds are very highly charged with elastic ilmenite, giving them a black color, and are more or less conglomeratic. The beds are intensely metamorphosed, and sometimes take the form of a coarse mica-schist. They are also penetrated by pegmatite and greisen dykes, and in their highly altered condition it is often difficult to distinguish them from the underlying Pre-Cambrians.

The *Slates* make the principal stratigraphical feature of the Lower Cambrian. The Tapley's Hill slate, near the upper limits of the lower series, is a very fine-grained ribbon slate with a coarse cleavage at a high angle. In descending order the rocks of this class show an increasing measure of metamorphism, through the stages of clay-slate, phyllites, talcose and chloritic slates, graphitic slates, and spotted slates. They constitute, for the most part, the foothills of the Mount Lofty Ranges, and in their decomposition make excellent grass land and soil suitable for vineyards, with orchards and gardens in the gullies. The slates are also extensively used as building stones.

The chief *Quartzites* in the series are (a) the Black Hill, Stonyfell, and Mount Lofty quartzite, which is about 1,000ft. in thickness; (b) the

Mitcham and Glen Osmond quartzite, about 100ft. in thickness; and (c) a laminated, somewhat argillaceous quartzite that immediately underlies the glacial till. There are other smaller quartzites distributed through the series having a thickness of a few feet each. The most of these quartzites have the structure of a fine-grained to coarse-grained arkose rock that has received secondary silicification, the silica being generally laid down in optical continuity with the original grains. The stone is usually too siliceous for the mason's tool, and is often very much jointed, which makes it unfitted for building purposes; at some horizons, however, a fair freestone is quarried, while the harder quartzites are much used for road metal and for railway ballasting.

The *Limestones* of the Lower Cambrian are represented chiefly at four horizons—(a) The River Torrens limestone, situated in the series not far above the basal grits, can be advantageously studied near Castambul, on the Torrens, where it runs parallel with the river for some distance. It is fully 100ft. in thickness. The stone varies from a white subcrystalline marble to a grey or bluish-colored rock. (b) At a slightly higher horizon than the preceding, is a dark-colored and earthy limestone, often siliceous, and accompanied by bands or nodules of black and speckled chert. In places it is of a lightish-grey color with a high percentage of carbonate of lime, and where much disturbed has a white, marble-like appearance. It occurs on the Sixth Creek and at the Montacute Mine, where it is much faulted. At Tea-tree Gully it is quarried and, after burning, placed on the market as a lime-cement. (c) The "blue-metal" limestone, like the preceding, is also a dark-colored and earthy limestone that has been much quarried along the foothills of the Mount Lofty Ranges, and used for metalling the roads; hence its popular name. It occurs as a very variable calcareous zone, about 50ft. in thickness, included in the phyllites that intervene between the thick quartzite of the Black Hill and the thinner Mitcham and Glen Osmond quartzite. (d) The Brighton limestones represent the highest members of the Lower Cambrian. They occur in three moderately distinct beds. The lowest is a bluish, siliceous limestone (40 per cent. of silica); the middle bed is a pinkish-colored limestone, about 15ft. thick, is sometimes oolitic, and contains about 86 per cent. of calcium carbonate; and the highest member is a buff-colored dolomitic limestone. The two lower members of the limestone are utilised by a company in the manufacture of a hydraulic cement. This limestone makes a very persistent horizon, extending from the Onkaparinga (south of Adelaide) and in a northerly direction through the agricultural areas into the Far North. All the limestones of the Lower Cambrian are more or less magnesian.

The *Glacial* beds, which occur about two-thirds up in the series of Lower Cambrian strata, are of exceptional interest, both on account of the clearness of the evidences and the extent of country which they cover. The greater portion of the beds consists of a typical glacial till in the form of an unstratified, gritty mudstone, carrying numerous erratics, up to 10ft. in diameter, which are promiscuously distributed through the finer material. Many of the erratics are angular or subangular, faceted, and glacially striated. They exhibit a great variety of lithological features, and are, in all cases, foreign to the neighborhoods where they occur. Included in the boulder clay are irregular masses of coarse grits and stones, and, at times, stratified slates that are wholly or nearly free from boulders; also, occasionally, grit and stony impure limestones, which are usually a foot or two in thickness. The tillite is rather irregularly indurated, being sometimes highly siliceous, and in other cases friable and weathers readily. The beds share in the general cleavage planes of the country, but the cleavage is coarse and attended by

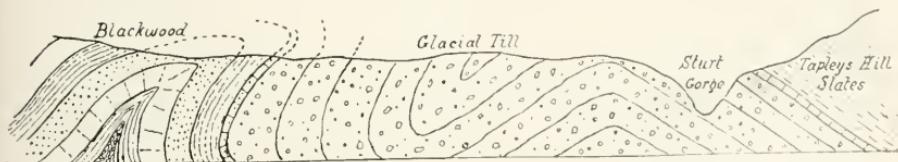


Fig. 2.—DIAGRAMMATIC SECTION OF CAMBRIAN GLACIAL BEDS. SHOWING OVERFOLD OF THE UNDERLYING QUARTZITES: RIVER STURT VALLEY.

a flaky exfoliation. In disturbed localities the boulders give evidence of tectonic strains. Those possessing unequal axes have usually, in such cases, rotated in their bed so as to bring their longer axis into line with the plane of cleavage. Most of these stones under the strain became transversely fractured with gaping fissures and were impressed with pressure striae. The latter are quite distinct from glacial striations and can at once be distinguished by their peculiar form and distribution on the surface of the stone. The beds, as measured across a vertical exposure of the till, have a thickness of 1,500ft. The Cambrian till is well developed to the south of Adelaide in the gorges of the Rivers Onkaparinga and Sturt, and in a northerly direction can be traced in repeated anticlinal and synclinal folds as far north as Hergott, a distance, meridionally, of 450 miles, with a width, measured from Port Augusta in the west to the Barrier Ranges of New South Wales in the east, of 200 miles. (Figs. 2 and 3.)

Within the limits just mentioned there is reason to think that the boulder clay was laid down by floating ice. This is inferred from the fact that there is no evidence of unconformity at the base of these beds, or the evidence of a

hard pavement having existed at the time when the glacial deposits were laid down—a feature that might be expected to occur in the case of land ice. There is, however, a very sharp line of division separating the till from the beds immediately below it, but no stratigraphical unconformity—all the evidences seem to point in the direction that the glacial material was dropped promiscuously on the floor of a sea bottom and was laid down in a continuity



Fig. 3.—TYPICAL FACE OF CAMBRIAN GLACIAL TILL, RIVER STURT.

of sedimentation. The permanent snowfield was probably not far distant. Many of the erratics appear identical with certain Pre-Cambrian rocks which have their outcrops at the present time to the west and south-west of the Cambrian glacial deposits. The Pre-Cambrian plateau that forms the greater part of the western side of South Australia was probably a portion of this

glacial highland from which tongues of ice came down to sea-level as far north as the latitude of Adelaide. The presence of regularly stratified deposits, destitute of erratics, which occur near the middle of the till, may represent an interval of milder climatic conditions during which the glaciers failed to reach the sea-level.

With the exception of a few obscure traces of Radiolaria in the siliceous limestones, the Lower Cambrian of South Australia appears to be quite destitute of organic remains.

Igneous rocks have but a rare occurrence on the western side of the Lower Cambrian axis, but they have a great development on the eastern side, where they are chiefly of an acid type.

UPPER CAMBRIAN.

The Brighton limestones, which are the highest members of the Lower Cambrian, have a sharp throw-down to the west, assuming an almost vertical position. The beds which immediately follow in ascending order are totally unlike any of the beds found in the lower division, and as this is true of all the succeeding beds an unconformity probably exists at this junction, although no stratigraphical discordance is clearly shown.

The Upper Cambrian forms a thick series, composed mainly of purple slates, purple or white siliceous quartzites, numerous siliceous and magnesian limestones, sandy limestones, oolitic limestones, *Archaeocyathinæ* marbles, and, near the top of the series, soft, reddish-colored sandstones, usually current bedded.

In the southern portions of the State the Upper Cambrian can be seen on the coast at Marino, near Brighton, where the junction of the two series can be studied. The strike of the beds is almost parallel with the coast, going south, and the junction is also well shown in the Field River, about a mile up from the beach at Hallett's Cove, and also on the Onkaparinga. The higher series has participated in the same tectonic movements that disturbed the lower, and are often crushed, folded, and overfolded. In the Willunga Ranges the beds are much faulted, the main range itself forms a fault-scarp of a thousand feet or more; they also outcrop on Yorke Peninsula, and they form the principal geological features of the Flinders Ranges in the Far North.

The most interesting horizon in the Upper Cambrian is a limestone which has a thickness of from 150ft. to 200ft., composed almost entirely of *Archaeocyathinæ* remains (Fig. 4), that must have formed important, coral-like reefs in the Cambrian seas. The *Archaeocyathinæ* limestones occur in the Willunga Ranges and on Yorke Peninsula, but they have their greatest development in the Flinders Ranges, where they make a prominent feature over a great extent of country.

At a little higher horizon than the *Archæocyathinæ* limestones there are one or two smaller limestones, which are also very fossiliferous. Trilobite remains are abundant, but in a very fragmentary condition. Near Wirrialpa sheep station, in the Eastern Flinders, there is a small limestone almost entirely composed of *Obolella* shells, and another made up of the nodules of *Girvanella*,

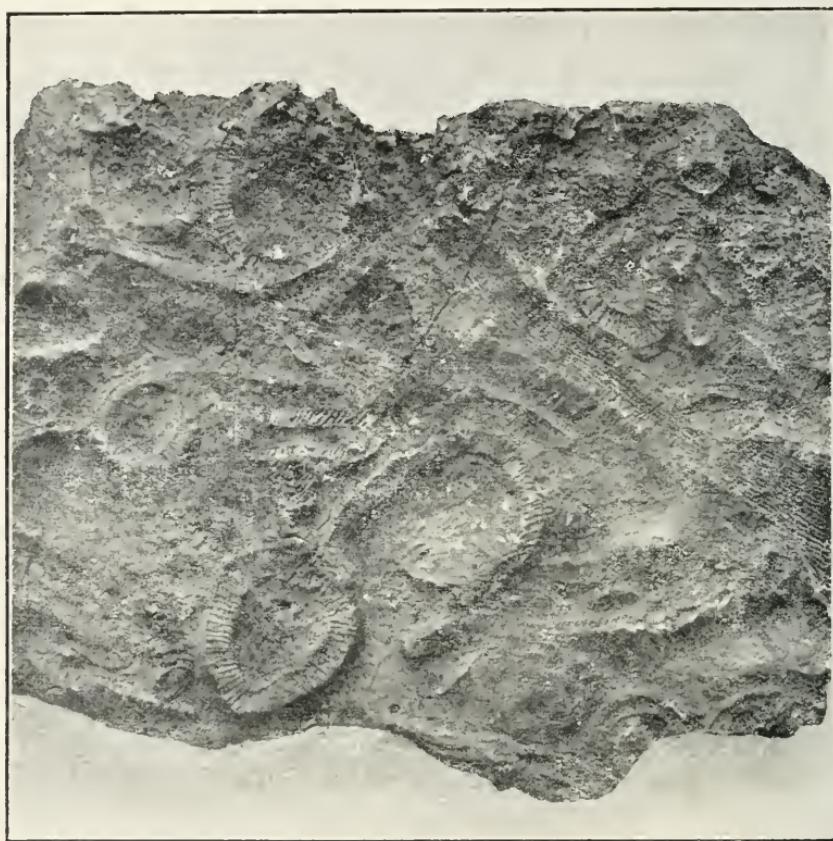


Fig. 4.—WEATHERED ROCK OF "ARCHÆOCYATHINÆ" LIMESTONE, FLINDERS RANGES.

which, in some cases, attain a diameter of 2in. Some of the limestones consist largely of sponge tissue and spicules, but these are seldom recognised in the very compact limestones, except by micro-sections, and in this form are difficult to identify.

PALÆONTOLOGY of the Upper Cambrian—

(?)*Alga* : Girvanella.

Spongiæ : Hyalostelia.

Archæocyathinae : *Archæocyathus*, *Ethmophyllum*, *Archæofungia*, *Pycnoidocyathus*, *Syringo nema*, *Somphoeyathus*, *Dokidocyathus*, *Dictocyathus*, *Spiroeyathus*, *Metaldetes*, *Protopharetra*, *Coscinocyathus*, *Coscinoptycha*; (including about 40 species.).

Brachiopoda : **Micromitra*, **Kutorgina*, *Obolella*, **Nisusia*, **Eoorthis*, **Huenella*.

Annelida : *Hyolithes*, *Salterella*, worm burrows and trails.

Ostracoda : *Leperditia*.

Trilobita : *Olenellus*, *Ptychoparia*, *Microdiscus*, *Agnostus*, *Dolichometopus*.

Pelecypoda : *Ambonychia*.

Gasteropoda : *Stenotheca*, **Micromitra* (*Platyeras*), *Ophileta*.

The *tectonic* movements that led to the elevation and deformation of the Cambrian sediments affected somewhat differently the Flinders Ranges as compared with the Mount Lofty and Barossa Ranges. The latter two mentioned were subjected to a great east and west pressure that resulted in a comparatively narrow belt of mountains thrown into parallel folds and over-thrusts pitching towards the west. In the Flinders Ranges there was a north and south pressure, which, in strength, almost equalled that operating in an east and west direction, which led to cycloclinal foldings, that is, great dome and basin structures, which in the case of the latter, formed the remarkable circular ranges, or "pounds," which are a distinctive feature in the arrangement of the Flinders Ranges.

Eruptive rocks of a basic type are comparatively rare in the Cambrian of the southern portions of the State, but there is an immense zone of granitic intrusions developed on the eastern side of the ranges, which extends far into the plains of the River Murray. In the northern Flinders, especially in the great dome-structure of the Blinman district, basic dykes are extremely common, and include "necks" as well as dykes.

There is a strong probability that the later stages of the Cambrian period in South Australia was characterised by an arid climate, or even desert conditions. The evidences which point in this direction are—(a) The prevailing red color of the rocks. (b) Many of the limestones, near the upper limits, are oolitic, or nodular, with concentric and wavy structures that appear identical with the surface travertine that forms to-day throughout the drier parts of Australia. (c) The newest members consist of red, friable, and cross-bedded sandstones which closely resemble wind-blown sand dunes.

*The genera marked with an asterisk are the corrected determinations made by Dr. Charles D. Walcott after examination of the types in the University of Adelaide.

ORDOVICIAN.

The only beds of Ordovician age known to exist in South Australia form part of the mountain system of Central Australia, of which the MacDonnell Range is the principal elevation. The MacDonnell and Hart Ranges consist of metamorphic rocks which probably belong to both the Pre-Cambrian and Cambrian divisions. The Ordovician strata form the James, the Waterhouse, the George Gill, and the Levi Ranges, which are parallel with the MacDonnells, but a little more to the southward. The late Professor Tate named the Ordovician deposits of Central Australia the Larapintine system, utilising for this purpose the aboriginal name for the Finke River, which stream intersects the beds. The series has a thickness of about 7,000ft., most of which consists of sandstones and quartzites. The fossiliferous horizons are limited to a few thin, impure limestones and a single horizon in the quartzite where impressions of a few species of mollusca occur in great numbers. The lithology, as well as the fossiliferous contents of these beds, is in strong contrast with the Ordovicians of the eastern States. The latter consist of dark-colored graptolitic slates, while beds of the same age in Central Australia are mostly arenaceous and have a fauna of Cephalopods, Mollusca, and Brachiopods.

PALÆONTOLOGY of the Larapintine System—

Spongiae : Hyalostelia.

Actinozoa : Two species, indeterminable.

Crinoidea : Fragments of crinoidal stems.

Trilobita : Asaphus (4 sp.).

Brachiopoda Orthis (2 sp.).

Pelecypoda : Conocardium, Pteronites, Palaearpa, Isoarca (7 sp.).

Gasteropoda : Eunema, Raphistoma, (?) Scalites, Ophileta, (?) Pleurotomaria.

Cephalopoda : Orthoceras (6 sp.), Endoceras (2 sp.), Actinoceras, Trochoceras.

PERMO-CARBONIFEROUS.

The period of interrupted sedimentation following the Ordovician, within the limits of South Australia, was very great. No rocks of Silurian, Devonian, or Carboniferous ages have been hitherto recognised in the State. There are some remarkable fragments of a thick conglomerate in Central Australia which is Post Ordovician, inasmuch as the rock carries derived fossils of Ordovician age, and is said to dip under the Cretaceous marine clays; but

outside these limits the stratigraphical position of the beds is unknown. The sediments which come next in the order of time are of Permo-Carboniferous age, and are of terrestrial origin, having been laid down by land ice under severe glacial conditions.

The *Glacial* beds of this age in South Australia stand related to beds of a similar kind and age which are found in a greater or less degree in all the Australian States, but more particularly in those that are situated in the more southerly positions, as South Australia, Victoria, and Tasmania. In the three States mentioned there are unmistakable evidences of upland glaciation. In South Australia and Victoria it was exclusively land ice that operated in glacially sculpturing the country and laying down very thick morainic deposits; while in southern Tasmania, New South Wales, Western Australia, and Queensland it was for the most part, if not wholly, a marine moraine, laid down by floating ice, proving that the glaciers came down to sea level.

The correlation of the Australian glaciation of this period with the Gondwana glacial beds of India and South Africa is supported by the homotaxial evidences gathered from the fossil flora and fauna of these countries as well as the stratigraphical relationship of the beds. Australia shares with South Africa in possessing some of the most impressive evidences of the magnitude of the glaciation that occurred in the Southern Hemisphere during Permo-Carboniferous times. There can be little doubt that at that time an ice-cap covered the southern portions of what is now the continental boundary, and extended much farther to the south. What has been preserved of this extinct glacial field in South Australia extends from Spencer Gulf, in the west, through the southern half of Yorke Peninsula, Kangaroo Island, the whole of Cape Jervis Peninsula that lies to the south of the Willunga Ranges, across to Strathalbyn, and disappears only when the newer sediments of the River Murray are reached. A small but remarkable outlier of this glacial field occurs at Hallett's Cove, on Gulf St. Vincent, about 15 miles south of Adelaide. (Figs. 5 and 6).

That the land stood at a higher level at that time than at present is proved by sundry borings. A bore put down in glacial till at sea level near Kingcote, Kangaroo Island, penetrated 1,100ft. of boulder clay before reaching bedrock. The Black Valley Creek bore, in the Inman Valley, proved the floor of the old glacial valley at a depth of 830ft. below the present sea level. No organic remains of any kind were found in these borings.

The Inman Valley supplies very remarkable evidences of glaciation. The ice-flow covered the upland plateaus in a continuous sheet, but had its greatest thickness in the pre-glacial valleys that were directed towards the north. In this system of drainage the Inman Valley was a lateral feeder

to the more important valley represented by the present Gulf St. Vincent. The snow-field that was the main source of the ice-cap lay to the south of the present continental mass, for the present coast, and even the islands off the mainland, show intense glacial action, the trend of the ice-flow being from the south towards the north. The floor of the Inman Valley, usually a very hard siliceous quartzite, when freshly exposed shows polished, striated, and deeply grooved pavements in a wonderful state of preservation. All the rocky knolls and prominences exhibit *roche moutonnée* features, with the collateral evidences of typical boulder clays, large erratics, glaciated stones, &c. The striated pavements show that the ice travelled in a north-westerly direction, and the body of ice was so great that it was not in the least diverted from its course by hills which are now 900ft. above sea level and 1,800ft. above the bottom of the glacial valley. The ice also overflowed the Bald Hills watershed in its passage across the peninsula towards

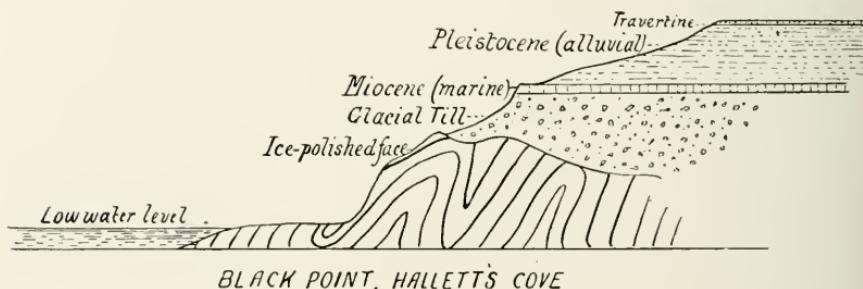


Fig. 5.

the valley of the present gulf. Moraines and large erratics occupy the summit of the watershed, and the quartzite bed-rock has been heavily glaciated.

Most of the larger erratics, which measure up to 19ft. in length, have been "plucked" by the ice from the belt of granite rocks that occupy the sea cliffs and coastal islands near by, and are the remnants of a much greater extent of similar country that at that time existed to the south.

One of the most striking features of this extinct glacial field is that it presents to our view an old Palaeozoic topography that has, through long ages, been buried under great thicknesses of morainic material, and is now being slowly uncovered and exposed by present-day atmospheric and fluviatile agents.

The Hallett's Cove outlier (Figs. 5 and 6) is also of particular interest, as it is the most northerly evidence of Permo-Carboniferous glaciation in South Australia, and, in the severity of its glaciation—exemplified by polished and grooved pavements—is quite equal to the Inman Valley evidences, situated 40 miles to the south.

The age of the glaciation is assumed to be Permo-Carboniferous as a matter of inference. No organic remains of any kind have been found either in the boulder-clay or the fluvio-glacial sandstones. Little effort, however, has been devoted to the discovery of such remains. It is highly probable that when diligent search is made similar evidences to those obtained in Victoria will be forthcoming. At present, the inference is based on the following considerations :—(a) The close lithological resemblance between the South Australian glacial deposits and those of Victoria, where the beds carry the

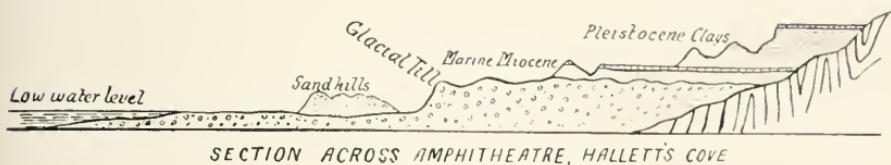


Fig. 6.

impressions of *Glossopteris*, *Gangamopteris*, and other characteristic plants. (b) The chronological position is determined within certain limits—the glacial beds resting unconformably on the Cambrian, while the older Cainozoic rocks rest on the eroded surfaces of the till. (c) There is no glaciation of the Australian continent with which these beds can be associated except that which occurred, more or less, in all the Australian States during the Permo-Carboniferous period.

No beds of Permo-Carboniferous age, other than the glacial, are known to exist within the limits of South Australia.

TRIAS-JURA.

During the early and middle Mesozoic periods (Triassic and Jurassic) the Australian continent was of greater extent than at present, and was a land of large rivers and freshwater lakes. Much of the land was low-lying and supported a dense and luxuriant vegetation. The freshwater sediments laid down at that time included much carbonaceous material from the decay of an abundant flora, and led to the formation of true coal seams, which are of great economic importance in several of the Australian States. The classification of these freshwater beds is based, mainly, on their plant remains. The Gondwana (or *Glossopteris*) flora, which is characteristic of the Permo-Carboniferous coal measures, disappears suddenly with the close of that series, while a very different flora is found in the beds next above them.

The Hawkesbury series of New South Wales—which, in ascending order, consists of the Narrabeen beds, the Hawkesbury sandstone, and the Wianamatta shales—are generally regarded as the oldest representatives of the

Mesozoic Division in Australia, and are classed as Triassic; while the Clarence series of the north-eastern portions of New South Wales, and the Ipswich beds of Queensland are usually considered to be of somewhat later age, and are designated Trias-Jura. The difference they respectively exhibit, however, may result entirely from varying conditions of deposition and the physio-graphical contrasts which influenced the distribution of plant life. The flora, throughout, maintained a considerable sameness, while the differences between the respective centres, in their representative generic forms, may arise from accidental causes and have but slight chronological significance.

It is probable that beds of this age have a more extended occurrence in Central Australia than is apparent from surface indications. Horizontal strata, of Cretaceous age, cover a vast extent of country and obscure the older geological features. The only clearly defined area of the Trias-Jura in South Australia is the Leigh's Creek coal basin, situated 375 miles from Adelaide, on the northern railway.

The beds, which consist of shales, carbonaceous shales, and coal interstratified with bands of limestone, ironstone, and sandstone are contained in a deep, narrow basin (16 miles in length and 6 miles in greatest breadth), enclosed by rocks of Upper Cambrian age. The basin is constricted near its centre, forming two main areas which are connected by a sunken, narrow valley or gorge. The surface, which is a plain only broken by low ranges of Cambrian rocks, gives no indication of this buried valley of the Jurassic period. Carbonaceous shale was discovered in making a dam. A bore put down to test the underlying strata passed through a belt of coal, 48ft. in thickness, and reached a depth of 2,000ft. without touching bed-rock. That this great thickness of sediment accumulated under lacustrine or fluviatile conditions is evident from the occurrence, at all depths, of the freshwater shell, *Unio eyrensis*.

The coal is hydrous and rather dirty. An analysis made of 17 samples, taken vertically through the main seam, gives the following average results :—

Volatile hydro-carbons.....	27·0
Carbon	42·0
Ash	14·0
Water	17·0

Shafts were sunk and a limited amount of coal was, at one time, put upon the market; but distance from the main centres of population and the poor keeping quality of the coal have prevented any extensive development of the coal as a marketable product.

The age of the beds is proved by the plant impressions that they contain. These are characteristic of the flora commonly met with in the Trias-Jura

of other parts of Australia. The following list is based mainly on determinations made by Mr. Etheridge, of the Australian Museum, Sydney : *Thinnfeldia odontopterooides*, *T. media*; *Macrotaniopteris wianamatta*; *Tæniopteris (Oleandridium?) fluctuans*; *Alethopteris* sp.; *Equisetum*, 2 sp.; *Podozamites* sp.; *Frenelopsis* (?); *Anthrophyopsis* (?), sp. indet.

It is probable that beds of corresponding age to those proved by the Leigh's Creek bore occur in other filled up basins in the northern parts of South Australia; but in the absence of fossils the evidences cannot be regarded as beyond doubt.

CRETACEOUS.

The Cretaceous System is extensively developed in central and east-central parts of Australia. It extends in a northerly direction, in places, to the northern coasts of Australia; to the westward it includes the Lake Eyre basin and to about the 134° meridian of east longitude. The southern limits, in South Australia, are a little south of Hergott and to the south of Lake Frome. Three-fourths of Queensland is covered by beds of this age, which are there known as the Rolling Downs Formation.

The Australian Cretaceous System is divisible into a lower and an upper series, which are in strong contrast to each other; the former being built up, in the main, by marine deposits and the latter chiefly by alluvial sediments.

LOWER (CRETACEOUS) SERIES.

Following the Jurassic period (during which there were continental conditions on a large scale), there was a general subsidence of the greater portion of what at present constitutes Central Australia, and the sea formed a Mediterranean. It was a land-locked sea, with highlands on the east, west, and south, in a horse-shoe arrangement. Heavy tropical rains carried much land-wash into this central sea and built up dark-colored and muddy sediments to a thickness of over 5,000ft. The rapid sedimentation that took place proved uncongenial to many forms of marine life, so that whilst the fossil fauna is moderately extensive at certain horizons, it is very meagre in comparison with the abundant life that prevailed in the Cretaceous sea of the Northern Hemisphere.

The fossiliferous horizons occur mostly either near the upper limits of the series or near the bottom, and are mainly limited to lenses of argillaceous limestone which occur in the shale. The fossils are, as a rule, in a bad state of preservation, the shelly matter being reduced to a soft and friable condition, leaving only internal casts of shells, &c. The beds are practically horizontal, and as the relief of the country is chiefly that of a slightly undulating surface with few and shallow streams, sections of the beds are seldom seen.

The beds form, however, a very large artesian basin which yields an abundant supply of useful water that is of the greatest economic importance in the development of some of the driest parts of the Australian continent. Our knowledge of the beds in question is, indeed, chiefly gathered from the large number of bores that have been carried out in tapping these artesian supplies. Whilst the lower series of the Cretaceous system is essentially marine in its origin, plant beds and small coal seams occur in some localities, indicating that alternations of conditions between salt and fresh waters prevailed at times.

PALÆONTOLOGY of the Cretaceous marine beds.—The following list of genera is taken from the valuable monograph by Mr. Robert Etheridge, jun., on the Cretaceous Mollusca of South Australia and the Northern Territory :—

Brachiopoda : Lingula, Rhynchonella.

Pelecypoda : Pecten, Syneyclonema (?), Protamusium, Pteria, Maccoyella, Gervillia, Aucella, Pseudavicula, Radula, Pinna, Inoceramus, Mytilus, Modiola, Nucula, Malletia, Idonearca (?), Trigonia, Corbicula (?), Cardium (?), Isocardia, Cyprina (?), Cytherea (?), Palaeomoera (?), Macrocallista (?), Tatella, Corimya (?). Pholadomya, Glycimeris.

Scaphopoda : Dentalium.

Gasteropoda : Cinulia, Ditremaria (?), Delphinula (?), Vanikoropsis (?), Natica, Anchura.

Cephalopoda : *Desmoceras, Haploceras, *Scaphites, Amaltheus, *Hamites, *Ancyloceras, Histrochoceras (?), Buchieeras, Belemnites.

Many of the examples in the above list are limited not only to single specimens, but in some cases to a mere fragment of cast; hence the number of doubtful determinations. Etheridge says—"The paucity of Cephalopoda life in the Lower Cretaceous of South and Central Australia, with the exception of Belemnite remains, is very remarkable, only three fragments representing Ammonites have come under my notice—one in Mr. Brown's collection and two in Prof. Tate's." In the Adelaide University collection there is a large fragment named by Professor Tate, *Crioceras australe*. It was obtained from Arkaringa Creek, about 70 miles west of the Peake, by Mr. W. H. East, and presented to the University by his brother, Mr. J. J. East.

In addition to the list of fossils given above, washings of the clay obtained from the Hergott, Tarkaninna, and Mirrabukinna bores yielded 56 species of Foraminifera, 20 of which had arenaceous tests. The vertebrate remains (including the Queensland area as well as that of South Australia) consist of a few fishes, a Chelonian, *Ichthyosaurus*, and *Plesiosaurus*.

* The Cephalopod genera marked with an asterisk were obtained from the beach at Point Charles, near Port Darwin. The specimens are all of small size, and are in the form of limonite pseudomorphs.

With respect to the palaeontological order of these beds, Messrs. Jack and Etheridge (*Geology of Queensland*, p. 390) assign the Rolling Downs series to the Lower Cretaceous epoch, but Tate regarded them as homotaxial with the Upper Cretaceous. He says,* "The facies of the fauna is more akin to that of the European Upper Cretaceous, while the palaeontological differences between it and the desert sandstone are too slight to justify the application of the terms Lower and Upper to them respectively; therefore we substitute Upper Cretaceous and Supra Cretaceous in their place."

UPPER (CRETACEOUS) SERIES.

As the result of epeirogenic movements of uplift that took place during the latter part of the Cretaceous period, the sea gradually drained off from the central portions of the continent leaving the Gulf of Carpentaria as the shrunken remnant of its former encroachment. Under subaerial conditions the marine sediments of the previous geological period, as well as the inliers of the older rocks that had formed islands in the Cretaceous sea, underwent denudation, and the disturbed material became built up into a series of fresh-water sands and clays that formed a thick mantle over the elevated area. This was probably effected, for the most part, only slightly above base-level and formed horizontal sheets of alluvium.

A further elevation occurred which invigorated the drainage, with the result that the low plateau, which had been built up mainly by subaerial sedimentation, became dissected and took the form of mesas and buttes—flat topped hills separated by wide gaps—which constitute the chief forms of physical relief in Central Australia to-day.

In Queensland, the earth movements seem to have developed their greatest intensity, for not only does that State possess the greatest thicknesses of deposit belonging to this period, but also their greatest diversity. In many places, thin coal seams were laid down, and in others, notably at Maryborough and Croydon, the sea made renewed encroachments over its former area and laid down fossiliferous sediments. In comparing the palaeontology of the lower and upper members of the Cretaceous System of Queensland, Mr. R. Etheridge says, "The organic remains of the Desert Sandstone and Maryborough beds partake in a great measure of the *facies* of the Rolling Downs (Lower Cretaceous) Formation, with an admixture of forms not hitherto recognised in the latter." (*Geol. and Pal. of Queensland*, Vol. I., p. 554.)

No marine fossils are found in the corresponding beds within the limits of South Australia, unless the occurrences of a few Cretaceous mollusca at a spot near Lake Gairdner, and at another locality, near Lake Frome, turn out to be on the Desert Sandstone horizon.

* Tate and Watt, *Horn Expedition, General Geology*, p. 62.

There is a general sameness in the lithological features of the beds as found in South Australia. They take their name of Desert Sandstone from their prevailing siliceous character and the desert nature of much of the country where they are found. The name is, however, a misnomer, as the beds seldom carry the features of a typical sandstone, and are often largely argillaceous. Outcrops are usually in the form of escarpments which, according to Mr. H. Y. L. Brown, have a general elevation of from 100ft. to 250ft. above the plains, although the greatest height met with by Tate and Watt, in the Horn Expedition, was estimated at 50ft. only.

The most singular and interesting feature of these beds is the secondary silicification to which they have been extensively subjected. The highest beds of the series—forming the surface of the tableland—are almost invariably highly siliceous and generally have a vitreous lustre. Where the original beds were sandy, the rock has been chalcedonized, the original quartz grains being held in a chalcedonic cement. A broken surface, similarly, becomes cemented into a breccia by the siliceous cement; or, if argillaceous, it is transformed into a porcellanite with a perfect conchoidal fracture. The infiltration has often followed very erratic lines, some portions of a bed being chalcedonized, while other portions have been left in a loose condition. Nodular concretions of silica are very common and take the form of chaledony, agate, jasper, opal, petrified wood, &c.

In 1904, under the kind guidance of Mr. W. Oliffe, who was at that time manager of Stuart's Creek stock station, I visited an aborigines stone quarry, situated on the run. It consisted of a rounded hill, more than five acres in extent, composed entirely of massive agate. The whole rock consisted of secondary silica and was traversed by parallel and concentric lines of various shades of color. It was formerly a noted place from which the tribes of the interior obtained the raw material for the manufacture of their domestic and warlike implements. The ground was covered with countless numbers of roughly flaked stones. The rock was much fractured—the effects of insolation—the pattern coarse, and the stone was deficient in lustre, all of which are defective qualities when considered from the standpoint of a possible economic value.

Various explanations have been offered to account for this secondary silicification which makes such an important feature in these beds. It would be too lengthy a task to review all these theories, but two may be referred to—(1) It has been suggested that deep-seated hot springs brought the silica to the surface and distributed it; (2) A view stated by Tate and Watts supposed the silica to have been a residue from the solutions of eruptive rocks that at one time covered the area, but have been subsequently entirely removed. This theory is based on three factors—(a) The brecciated

floor of the tablelands, which is supposed by these authors to have been broken up by the lava flows; (b) the presence of agates; (c) the presence of "obsidian bombs." The authors concerned admit—"Of this suppositious volcanic formation all that remains are the agates and the obsidian bombs. The theory seems wild in the extreme because of the widespread silicification and the absence over its area of any traces of actual volcanic outbursts, nevertheless, no other explanation accounting for the several phenomena appears to us admissible." (Horn Exp., Gen. Geol., p. 71.) Both these theories are inadequate when the extent and uniformity of the silicification are taken into account. The mound-springs of Central Australia, at the present time, do not deposit silica, but calcium and magnesium carbonates, and there are no evidences of former siliceous tufa deposits in the region concerned. Agates can form under other conditions than as amygdaloids in volcanic rocks, and the latest views of the so-called "obsidian bombs" (Australites) is that they have had a meteoric origin.

That the silicification of the Desert Sandstone has taken place subsequently to its deposition all are agreed, and the present writer is strongly of opinion that its origin can be accounted for by the peculiar climatic conditions of the country. The region where it occurs is mostly desert, or at least arid, with a limited rainfall and defective drainage. The surface waters, under the sun's rays and by contact with heated rocks, attain a relatively high temperature. Moreover, the country is saline, and the waters, which are usually charged with alkalies, become a solvent for the silica in the rocks, and, on evaporation of the water, the silica becomes precipitated. This precipitation takes place chiefly in the interstices of the rocks, cementing the grains or brecciated fragments into a chalcedonized or opalized mass, and at times fills up cracks and joints in the rock, or forms stalactites in open bedding planes. This explanation is supported by the almost universal occurrence of the silicification throughout Australia wherever the climatic conditions are favorable, and also from the uniformity in its mode of occurrence.

Parallel processes of chemical reactions occur throughout the region. Gypsum plays a similar although more limited part in the same way; gypseous clays and pseudomorphs of wood and shells in gypsum are common. In a calcareous district, chiefly in Cambrian and Tertiary areas, a surface travertine forms as a characteristic feature in all parts of the State, except the very wettest. Phosphoric acid combines in various degrees with the limestones and forms a phosphate of lime, which is also very widely distributed throughout the State. These respective surface reactions are all coincident with arid conditions. Parallel instances are found in desert regions in other parts of the world.

The breaking down of the Desert Sandstone beds supplies most of the material which is building up the recent sediments of the interior. The sand is gathered by the wind into long parallel ridges, separated from each other by flat "clay-pans" that carry water for a short time after rains, while the hard bands and nodules in the sandstone, when broken down, become a residuum, covering vast areas with loose stones ("gibbers"), forming a characteristic stony desert.

Plant Impressions.—“The topmost stratum of the table-topped hills to the south of Oodnadatta and extending into the basins of Lakes Torrens and Gairdner, which has the structural peculiarities of the Desert Sandstone, except that it is rudely fissile, contains plant impressions.” (Tate and Watt, *op cit.*, p. 65.) Similar plant impressions occur in beds of different lithological character on the south side of Lake Frome and a few other localities. The impressions are limited to leaves, and in all cases are those of exogens. Tate gives the following determinations:—*Magnolia brownii*, *Cinnamomum* sp., *Apocynophyllum mackinlayi*, *Bombax sturtii*, *Eucalyptus diemenii*, *Banksia pregrandis*, *Quercus greyi*, *Q. wilkinsoni*, *Alnus muelleri*. The exact geological horizon of these phytiferous beds is uncertain. Tate says that “the flora is analogous with that at Vegetable Creek (N.S.W.) and Dalton (N.S.W.), described by Baron von Ettingshausen, and on palaeontologic grounds has been regarded by him as Eocene.”

CAINOZOIC.

The Cainozoic sediments of South Australia give evidence of remarkable alternations in the level of the land in relation to the sea. Repeated submergences have left their records in the form of marine deposits of various ages. Elevations of the land are indicated by unconformities, freshwater deposits, and important modifications of the river systems. The data on which a chronological order can be constructed are almost exclusively such as are afforded by the mollusca.

The late Professor Ralph Tate, following the example of Lyell, classified the marine Cainozoics on the basis of the percentages of the recent forms found in the beds. In this way he concluded that the Australian Cainozoic Division included faunas that might be regarded as corresponding to the Eocene, Miocene, and Pliocene of other parts of the world. Deep-sea dredging in South Australian waters, carried out chiefly by Dr. J. C. Verco,* has yielded important results and brought to light several species living in deep water on the coast that were first recognised and described by Tate as Lower

* Mr. Charles Hedley, of the Australian Museum, Sydney, has also done valuable work in deep-sea dredging off the New South Wales coast.

Cainozoic fossils. This has considerably increased the percentage of living forms in the fossil fauna, and, as a consequence, Australian palaeontologists are inclined to assign a somewhat later chronological position to these beds than Professor Tate had done, classing the oldest marine beds of the series as Oligocene, or even Miocene. Under these circumstances it is expedient to use only such general terms in classification as indicate a homotaxial relationship with Cainozoic faunas in other parts of the world.

The Cainozoic order of succession in South Australia includes (if we reckon in the recent estuarine elevations) five distinct horizons of marine sediments. In addition to these marine beds, there are, at the base of the series, as well as in the upper portions, deposits of freshwater origin, as is shown in the Table on pp. 209-210

PALÆOGENE (LOWER CAINOZOIC).

The marine sediments of Lower Cainozoic age in Australia are limited to the south-western and southern coastal districts, including both sides of Bass Strait. In the eastern States the period was one of terrestrial conditions and volcanic extrusions, which has left its evidences in old river valleys, containing auriferous gravels, often buried under sheets of lava. In South Australia, the early stages of the Cainozoic were also terrestrial, but these were succeeded by a period of submergence of long duration.

Freshwater Beds.—In most places in South Australia where the lower marine beds have been penetrated they have been found to rest on a series of sands and carbonaceous clays. These have hitherto yielded no fossils, but are evidently of freshwater origin. The black color of the beds and occurrence of lignite, in places, have repeatedly raised the delusive hopes in the minds of local residents that they have discovered a coalfield. At the north side of Aldinga Bay these beds rise from beneath the marine limestones in the sea cliffs where they can be conveniently studied. There they consist almost wholly of coarse sands, argillaceous sands, and fine gravels—often ferruginous—but only feebly cemented. The very general occurrence of these freshwater beds as the lowest members of the Cainozoic series, and their highly carbonaceous nature, suggest a country of low relief, possibly reduced to base-level before the incursions of the sea that brought in the marine sediments of the succeeding stage.

First Marine (Cainozoic) Series.—These beds, which represent the lowest marine series of the Cainozoic order, at one time extended from the Bunda Plateau, at the western limits of South Australia, across the whole of the southern portions of the State, including the region now occupied by the Mount Lofty Ranges. The most northerly extension of these beds is within

the valley of the River Murray where they extend into the south-western portions of New South Wales. They have been greatly reduced and dismembered by denudation and faulting. Scores of scattered outliers occur, some of which are only a few square yards in extent, and are rapidly passing into extinction.

In the greater number of cases the beds outcrop from near sea-level up to an altitude of about 200ft. above the sea. In the neighborhood of Adelaide, however, there are some extraordinary contrasts in this respect, ranging from 1,681ft. below sea level (in the Croydon bore) to 900ft. above sea level, on the Hindmarsh Tiers. These great differences of level have been brought about by certain earth movements that will be referred to later.

Lithologically the beds consist, in the main, of calciferous sandstones, argillaceous limestones, polyzoal limestones, and a chalky limestone with flints; the last of these occurring at the head of the Great Australian Bight, and also in the district of Mount Gambier. The calciferous sandstones in many places have been leached of their lime content, and silica has been interstitially deposited, producing a chalcedonized rock. In the neighborhood of Adelaide and Gulf St. Vincent rapid and striking changes occur in the sedimentation within short distances, pointing to littoral or shallow-water conditions, while the more chalky nature of the beds at the Great Bight and at Mount Gambier are indicative of deep-water conditions.

The following are the more important localities for the occurrence of the marine beds of Palaeogene age in South Australia:—

1. The chalk-rock and polyzoal limestone of the *Bunda plateau* (Great Australian Bight), where the cliffs consisting of these beds are 250ft. high, and pass to a depth of 500ft. below sea level.
2. *Adelaide*, proved in the Kent Town and Croydon bores. In the latter they have a thickness of 966ft.
3. *Gulf St. Vincent*, in sea cliffs at Aldinga Bay, Noarlunga, Edithburgh, &c.
4. *River Murray Cliffs*, as far as Overland Corner; also in numerous well sinkings on the Murray Flats.
5. *Mount Gambier and district* to the Glenelg River, in Victoria, near the border. Caves with beautiful displays of stalactites are in these limestones at Naracoorte. (Fig. 7.)

PALÆONTOLOGY.—The fauna of the oldest Cainozoic marine beds is fairly extensive. In 1896 Professor Tate published* a palæontological summary of the fossil forms that had been determined from the Aldinga and Adelaide sections as follows:—"Pisces, 2; Cephalopoda, 2; Gastropoda, 182; Scaphopoda, 3; Pteropoda, 1; Lamellibranchiata, 77; Palliobranchiata, 25;

* Trans. Roy. Soc., S. Aus., Vol. XX., p. 125.

Polyzoa, 47; Echinodermata, 22; Zoantharia, 14—total, 375. Of this number, 202 are restricted species. The genera amount to 375, being an average of little more than two species to each genus. Though only two genera are peculiar, viz., one bivalve (*Limarca*) and one coral (*Bistylia*), yet the stratigraphical distribution of several genera is of a high antiquity, as for example—*Plagiarea*, *Plesiotriton*, *Clavilithes*, *Conorbis* [*Conus*], *Mesalia*, and *Ampullina* [*Euspira*], among the mollusca; *Paradoxechinus*, *Holaster*, *Cardiaster*, and *Hemaster*, among Echinodermata; *Notocyathus* (?), *Trematotrochus*, *Conosmilia*, *Cyathosmilia*, and *Graphularia*, among Zoantharia. Of all



Fig. 7.—STALACTITES IN ONE OF THE NARACOORTE CAVES.

Australian sections they are the richest in Palliobranchs and Echinoids. The living species of mollusca are *Saxicava australis* [*arctica*] and *Rhynchonella squamosa*, or [as calculated by Tate] two in a total of 290, which equals 0·69 per cent."

Among the commoner genera are—*Turritella*, *Conus*, *Voluta*, *Fusus*, *Latirus*, *Murex*, *Lampusia*, *Cypraea*, *Natica*, *Scalaria*, *Dentalium*, *Lima*, *Pecten*, *Limopsis*, *Crassatellites*, *Terebratula*, *Magellania*, *Cellepora*, *Retepora*, *Lorenia*, *Paradoxechinus*, *Cassidulus*, *Fibularia*, *Echinolampas*, *Cardiaster*, *Eupatagus*, *Flabellum*, *Placotrochus*, *Deltocyathus*, *Amphihelia*, *Cyathosmilia*. Some of

the material is very rich in Foraminifera—nearly 200 species have been determined. Pseudomorphs in chalcedony and gypsum are common in places. Very beautiful selenite casts of Brachiopods, showing the brachidia, occur in the cliffs of the River Murray.

NEOGENE (MIDDLE CAINOZOIC).

Second Marine (Cainozoic) Series.—There is a distinct palaeontological, and sometimes a slight stratigraphical, break between the first marine series and that which comes second in the order of succession. Notwithstanding the great length of time that must have occurred between the two periods of marine conditions, no beds of intermediate age are known to exist. The newer series commonly rests on the older. A slight unconformity is sometimes apparent, but, for the most part, no variation of dip can be recognised in the plane of junction of the two sets of beds. In a few instances the newer marine beds rest on older rocks, as at Hallett's Cove, where they rest directly on the Permo-Carboniferous till, and at Marino, where they rest on Upper Cambrian.

The chief localities where these beds outcrop in South Australia are (*a*) the cliffs of the Great Australian Bight, where they occur as the top layers and are of marble-like texture; (*b*) in sea cliffs of Gulf St. Vincent, at Hallett's Cove, Aldinga Bay, and Edithburg; (*c*) underlying the City of Adelaide, and were formerly exposed in the banks of the River Torrens, behind Government House; (*d*) oyster beds, forming the topmost strata in the cliffs of the River Murray as far as Overland Corner. The beds have an insignificant thickness in comparison with the older marine, generally ranging from 6ft. to 20ft.

In their lithological features the beds are typically calcareo-arenaceous, and, like the old marine, have been much leached. Tests formed of aragonite have disappeared, and the rock, where indurated, is often a mass of fossil impressions. The sands are frequently incoherent, and where induration has occurred it is usually partial in its character, soft and hard portions exist in juxtaposition.

Resting on the marine fossiliferous beds, in many places, is a white amorphous limestone, practically destitute of fossils, and carrying scattered sand grains and earthy material. The rock weathers into rough craggy faces and is at times of nodular structure. This portion of the section is generally the most conspicuous part of the outcrop. This limestone has all the appearance of a surface travertine that was probably laid down under subaerial conditions following the elevation of the marine sediments. If so, it represents the equivalents of the calcium carbonate that was extracted from the shelly sediments by the leaching process, and on evaporation of the

water carrying the lime in solution the latter was precipitated on nuclei and ultimately became a solid calcareous crust. This process of travertine formation is going on at the present time, and it is not uncommon to find two such travertine horizons in the same section which are of diverse ages and separated by thick deposits of a different nature. This supposed ancient travertine can be advantageously studied in the Aldinga Bay cliffs, extending along the whole length of the outcrops.

The fauna differs from that of the older marine series in its more littoral character, and also in that the fossil forms have a facies that approximates nearer to that of recent times. There is a relative scarcity of Brachiopods, Echinoderms, Polyzoa, Corals, and Foraminifera; while *Ostrea*, of which there are three species, none of which are represented in the older marine, is always a characteristic genus and is often present in immense numbers. Other typical genera are *Pecten*, *Spondylus*, *Mytilus*, *Lucina*, *Natica*, *Terebra*, etc. Large examples of *Orbitolites complanata*, some reaching an inch in diameter, are moderately common and widely distributed.

Movements of Uplift (epeirogenic).—The dominant feature of the later Neogene stage in South Australian geology was an epeirogenic movement that gave an increased elevation to the land. During the earlier Cainozoic periods the sea made two transgressions of the southern portions of the continent and two recessions. The more important of the upward movements occurred subsequently to the second submergence, when a reaction towards elevation was established. The sea retreated, and a long period of subaerial waste ensued, which has persisted, subject to some secondary alternations of level, to the present day.

These positive earth movements probably extended, with increasing effects, throughout most of the Neogene stage; the Mount Lofty and other South Australian highlands were elevated and gradually sculptured into their existing forms. The soft marine sediments of earlier Cainozoic times were easily operated upon by erosive agents and gradually disappeared from most of the exposed situations, leaving only a few scattered and often widely separated fragments that demonstrate their one-time greater extent.

Movements of Depression (Senkungsfelder).—In the later stages of the epeirogenic movements (that gave a greater elevation to the land) there were isostatic compensations which led to a measure of collapse and local depressions of the earth's crust. Block-faulting on a large scale divided the highlands into vast segments with scarp faces and long slopes, which are still recognisable in the physical outlines of the ranges. Moreover, a trough-fault on a large scale was either started at this time or received an accentuated development that gave rise to the great Rift Valley of South Australia.

Marine Sediments of the Rift Valley, or Third Marine Series.—This sunken area, or graben, follows the line of St. Vincent Gulf and continues northward to the head of Lake Torrens. The trough thus created has had the effect of preserving, in their greatest thickness, the older marine sediments, amounting to nearly 1,000ft. It also contains a marine fossiliferous deposit of newer Cainozoic age which is unique for Australia. These beds, which are 320ft. in thickness, do not appear at the surface, but were proved in bores carried out at Croydon, Dry Creek, and Smithfield, all situated on the coastal plain adjacent to Adelaide, at a depth of about 400ft. below present sea level. Professor Tate's determinations of the fossil forms obtained in these bores proved that about half the species were peculiar, about 30 per cent. were common to the Miocene (the second marine series) fauna, and about 20 per cent. represented recent species in Australian seas. On these evidences Tate placed the fauna as "Older Pliocene."

When these fossiliferous sands were laid down the present gulf area, as well as the coastal plains, must have stood at least 400ft. higher than it does to-day, and it seems likely that it was due to the relatively rapid sinking of the ground along the line of rift that a narrow arm of the sea was admitted up the depression. The submergence lasted long enough to accumulate more than 300ft. of marine sediments, and the latter form excellent geological time-indicators, both in relation to the earlier periods and also as a half-way stage between the latter and the present; for the sea, which retreated for a time, has once more returned to the rift valley and now flows 400ft. above the shelly sands it left in its previous encroachments. What happened in the interval must be told in the history of the Pleistocene period.

PLEISTOCENE.

The invasion of the rift valley by the sea during Pliocene times was probably a purely local transgression, incidental to the development of the valley-trough, and was therefore much more restricted than the first and second submergences which occurred during the Cainozoic period. That such a local-incoming of the sea should happen concurrently with a continuous uprising of the region is quite possible, and is, indeed, suggested by the fact that during an interim when the rift movement was either inactive or slight, the elevatory movements were in excess and had the effect of draining off the sea from the valley-trough and thereby closing the Pliocene marine stage. There followed a long-period of subaerial action during which the sinking zone received alluvial wash to a thickness of 400ft. or more, and some very remarkable changes occurred in the physiographical conditions of the country.

In the earlier Pleistocene the country was abundantly blessed with great river systems, and in the latter part of that period, coming down to the present, it has become a land of dead rivers and subarid climate.

OLDER PLEISTOCENE.

A Period of Great Rivers.—At no very distant date in the past Central Australia, instead of being, as at present, a great basin of inland drainage, was a main watershed, the rivers of which found their outlet into the Southern Ocean. The drainage was essentially in a north and south direction, and, for the most part, followed the main lines of strike in the geological structure of the country. The only surviving example of these aforetime continental river systems is the River Murray, and even that river basin has been dismembered and truncated on its north-western side. The evidences which prove the former existence of these lost rivers are the occurrences of ancient river valleys, often several miles in width, containing more or less consolidated river sand and gravels that have no relationship to the present lines of drainage. The main arteries of these old and obsolete waterways can be traced for hundreds of miles. One line coming down from the north-east found its outlet to the southward *via* what is now the drowned valley of Gulf St. Vincent; and another, coming from the interior more directly to the northward, followed the line of the great lakes and flowed down what is now the drowned valley of Spencer's Gulf.

A New Divide (Fig. 8).—The momentous change in the physical relief of the country, by which South Australia lost most of its rivers, came about gradually and took the form of a sinking down of the central portions of Australia, whilst the rim of the basin, on the southward, was either stationary or possibly had a tendency upwards. This earth ridge, which created a new water-parting within about 150 miles of the southern coast, broke up the old river systems. Not only was the drainage of Central Australia prevented from reaching the sea, but the new watershed threw back to the interior the drainage from its northern slopes and left only a greatly impoverished supply on its southern side.

The Rift Valley of South Australia (Fig. 9).—It is probable that this important factor in the geological sequence of South Australia was developed, to some extent, in Pre-Pliocene times. There are the clearest proofs that the trough has sunk an additional 700ft. since the Pliocene sea first invaded the valley. In the neighborhood of Adelaide four successive steps or platforms of Cambrian rocks can be detected between the dissected peneplain of the Mount Lofty Ranges (1,500ft. above sea level), and the Cambrian floor which was proved in the Croydon bore at a depth of 2,200ft. below sea level. It

SECTION ACROSS WATERSHED.

Fig. 8.

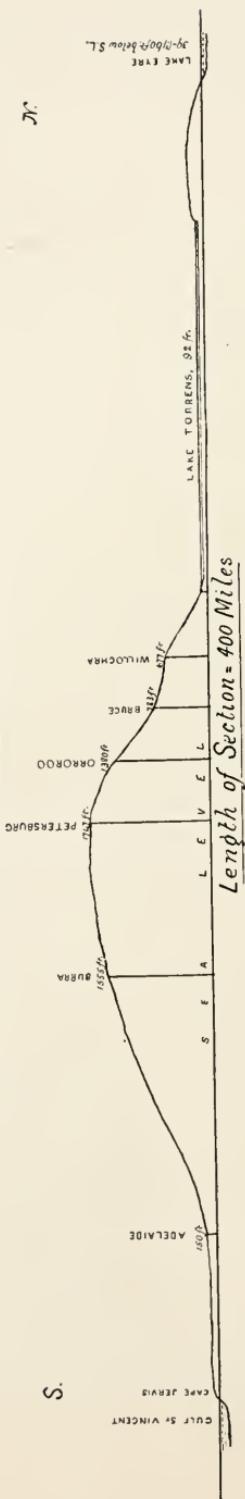
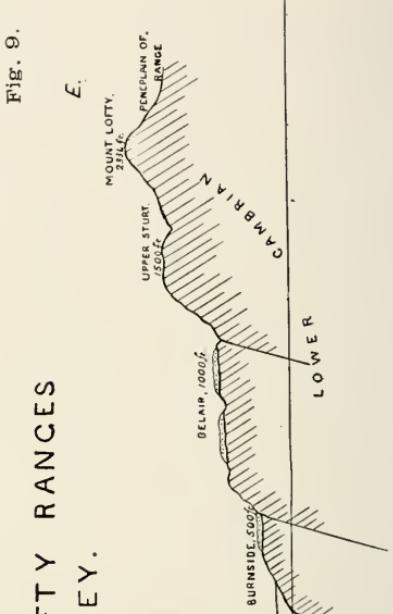
STEP-FAULTING OF MOUNT LOFTY RANGES
DOWN TO RIFT VALLEY.

Fig. 9.



Length of Section - 12 Miles

would thus appear that this rift-trough comprises an area that has undergone compound faulting in narrow parallel blocks that have an aggregate vertical displacement of about 4,000ft.

The development of this great meridional trough completely changed the direction of the local drainage. Not only were the northern rivers cut off by the southern rim of the great Senkungsfeld of the interior, but the existence of a slowly sinking zone on the western side of the South Australian highlands interfered with the drainage nearer the coast, and ultimately compelled the rivers to take a westerly instead of a southerly direction—that is, a direction opposed to the general strike and physical relief of the country, as will be seen later.



Fig. 10.—EXTINCT VOLCANO OF MOUNT GAMBIER.—Segment of Crater is seen in the distance. The Valley Lake occupies the middle distance, and the Leg of Mutton Lake in the foreground. The last two mentioned are areas of subsidence.

Volcanic Eruptions.—During some part of the Pleistocene period there was a field of volcanic activity in the South-East of the State. A number of small vents occur, in a lineal order, from Mount Schank at the south-east extremity to Mount Graham in the north-west, covering a distance of about 35 miles. Mount Schank is the most perfectly preserved cone and Mount Gambier (Fig. 10) is the largest of the group. The cones consist almost entirely of ash, lapilli, and scoriæ, intermixed with masses of ejected lava and torn-up

local rocks. Only small effusions of lava have occurred, and these have issued mainly from lateral vents near the base of the cones. Plant impressions of the same kinds as the existing flora have been preserved between layers of ash. On the southern slopes of Mount Graham there are the remains of an ancient sea beach, about 40ft. above the present level of the plain. It has the appearance of a ledge on the side of the mount, but is somewhat obscured by rainwash. The evidence shows that the sea must have encroached upon the locality and again receded since the volcanoes were in eruption.

NEWER PLEISTOCENE.

The newer Pleistocene is represented by the work done by the young rivers, consequent on the epeirogenic uplift on the one hand and certain stages in the trough subsidence on the other. The rivers of the South Australian highlands are mostly in their juvenile stage and not infrequently cut the older lines of drainage transversely. This follows as a natural consequence of the westerly direction imposed on the drainage by the development of the rift valley that admitted the sea. Illustrations of this can be seen in the Rivers Broughton, Wakefield, Light, North Para, South Para, Little Para, Torrens, &c., all of which intersect the ranges and flow through deeply incised gorges in their passage to the South Australian gulfs.

Next to the River Murray the Onkaparinga is the oldest river of the South Australian coast. It has had a remarkable and chequered geological history. It is, in part, an antecedent river, having been a tributary to the main stream that occupied the valley of the gulf in the older system of drainage. Its head waters are older in their features of erosion than the lower reaches of the river, inasmuch as the river at a certain point of its history became diverted from its original course and, following on the general uplift, cut for itself a new bed in hard rock as an "incised meander." Apart from the Murray and the few small streams which find their way into the gulfs, there are no rivers flowing to the sea along the South Australian coast.

The alluviation belonging respectively to the older and newer systems of drainage can be easily distinguished. The older of the two is characteristically upland in its occurrence, and its sands and gravels have become consolidated over wide areas by the infiltration of very hard siliceous or ferruginous cements. The newer river deposits have built up the piedmont plains, and, although often of great thickness, they are almost invariably in the form of unconsolidated clays, sands, and gravels.

.The disruption of the older river systems, consequent on the development of a new and coastal water-parting, had a marked effect on the climate of

the country. Following on the general lowering of the height of the land in the interior, there would be a diminished rainfall; the existence of a basin of inland drainage would result in saline conditions of water and soil, and tend to create sterility and barrenness, as well as an increase of temperatures, which would be cumulative in their effects. There are many proofs that in comparatively late geological times Central Australia had a plentiful supply of fresh water, an abundant vegetation, and an extensive fauna of large herbivorous mammals, much in contrast to its present condition.

It is to this late period that we must refer most of the remains of the large extinct marsupials and struthious birds, which are found plentifully in the terraced sands and gravels of the present river valleys, in the alluvium of the coastal plains, and in the muds of the dried up lakes of the interior of the country. Lake Callabonna, situated to the north of Lake Frome, has yielded a great assemblage of these extinet forms, including the only complete skeleton of the *Diprotodon* known, an example of which may be seen in the Adelaide Museum. These remains are not known to occur in the deposits of the older system of drainage, but they are common in the alluvial beds of the existing rivers, although, usually, at some elevation above the stream or in the lateral flood plains. It is not impossible that the *Diprotodon* and other extinct marsupials survived into recent times, and the animal known traditionally to the Australian aborigines as the "Bunyip" may have been the huge *Diprotodon* or some other of these extinet forms.

The more remarkable examples of the Pleistocene fauna, found within the limits of South Australia, include *Diprotodon*, the largest of all known marsupials, rivalling the rhinoceros in size and quite as massive; *Nototherium*, which was next to the *Diprotodon* in size, and possessed wombat characteristics; *Phascolonus*, an extinct gigantic wombat; *Phascolomys*, the genus of existing wombats; *Thylacoleo*, only known by its skull and powerful teeth, which are suggestions of a carnivorous habit, and is known as the "marsupial lion"; *Sarcophilus*, or "Tasmanian devil"; and several species of *Macropus*, or kangaroos, including forms that were larger than any existing species of that genus. *Genyornis* was a large struthious bird, closely allied to the existing cassowaries and emus, about 6ft. 6in. in height; and *Dromornis*, another of these heavily-built birds also lived during the same period, as well as smaller examples of a similar kind.

The somewhat sudden appearance of so distinctive and highly differentiated a fauna within the Australian area is significant of important geographical changes that favored the emigration of animal life. The conditions which brought about such migrations in late Cainozoic times are unknown to us, and it would be hazardous to attempt an explanation. There can be little doubt,

however, that the extinction of many of these forms was largely due to the desiccation of the country, following on the loss of the older river systems and the consequent effects in the pauperization of the herbage.

RECENT.

Some of the more striking physical changes of recent geological times have reference to the fluctuations of the sea in relation to the land. When the sea retreated from St. Vincent Gulf, at the close of the Pliocene period, terrestrial conditions ensued until the alluvium in the neighborhood of Adelaide had accumulated to a thickness of over 400ft. The sea returned to the South Australian valley in early Recent times, and then again retreated to some extent, which permitted a further alluviation to take place before the sea once more transgressed its marginal areas. Following this last encroachment a reaction towards elevation took place, and as this movement is apparently still in progress it brings us down to present times.

The evidences for these oscillations of level are shown in shallow excavations and in the raised beaches which occur along the entire southern coast of South Australia. In the raised estuarine areas, near Adelaide, there are two marine beds of Recent age, the older has its upper limits a little below low-water mark, and is dredged in the Port Adelaide River and at the Outer Harbor, &c., while the newer marine bed is about 12ft. above sea level. These two Recent sea deposits are separated from each other by about 17ft. of alluvium, the latter supplying evidences of dry land conditions in the features of sun-cracked surfaces and a crust of surface travertine. In the older Recent marine bed several species of shells occur, which, although still living on some of the warmer coasts of Australia, no longer exist in our local waters; but in the newer Recent marine bed all the forms of life are identical with those found in the adjacent sea and occur in about the same relative proportions.

The recent elevatory movements have been particularly pronounced in the South-Eastern portions of South Australia, for while the raised sea bed in the neighborhood of the gulfs is only about 12ft. above high-water mark, in the neighborhood of Tantanoola and Glencoe it is probably from 100ft. to 200ft. above sea level. This raised area embraces a wide coastal plain some hundreds of square miles in extent, with numerous lagoons, ancient sand dunes, and inland sea cliffs, an example of the last named being "Up and Down Rocks," near Tantanoola, 15 miles distant from the present coast. Throughout most of the raised area the sea cliffs consist of indurated blown sand (cross-bedded), which indicates that elevation has been followed, to some extent, by depression.

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METEOROLOGY.

(a) CLIMATE AND RAINFALL.

SOUTH AUSTRALIA enjoys one of the most agreeable and salubrious climates in the world. The State is situated between latitudes 26° and 38° south, and as it is bounded on the southern side by the Southern Ocean, which extends from the West Coast in the Australian Bight for a distance of about 1,500 miles, a considerable portion of the territory may be classed as coastal. During the summer months the heat is at times trying, but owing to the purity and dryness of the atmosphere the high temperatures are not so enervating as lower readings in a moister climate. The clear skies and dry heat of the summer are healthy. Even with a temperature well over 100° in the shade cases of sunstroke are extremely rare, and the heat is seldom so severe as to prevent persons following their ordinary occupations.

The hottest months in the year are December, January, and February, when the temperature away from the coastline frequently exceeds 100° in the shade. November and March are also hot months, but the nights, especially in the former month, are cool and the heat seldom of long duration, rarely reaching 100°, except in the Far North, and, coming in suddenly with a strong northerly wind, is followed by a change to cool or even cold weather. The summer may therefore be regarded as extending from November to March; after that the temperature falls rapidly, seldom exceeding 90° in the shade.

The weather during April and the greater part of May is perfect, and the same remark applies to most of the winter (particularly in the North) and until the end of October. The coldest months are June, July, and August. Over the northern highlands and the Mount Lofty Range the temperature during these months frequently falls below freezing point (32° Fahr.), and frosts, especially during a dry winter, are rather frequent. Snow occasionally falls over the elevated parts of the country, but does not remain on the ground for long. Over the lowlands, more especially along the coastal districts, the range of temperature is not extreme. Nevertheless, the cold is sometimes felt very much during the winter months, because of the contrast it emphasizes between the summer temperatures and the genial weather which prevails in other portions of the year. Near the coast the summer heat is greatly reduced by the cool breezes which blow from off the sea, and in settled weather these winds set in regularly each day towards noon. A striking example of

the cooling effect of the sea breeze and the influence of the ocean on the temperature will be found at Robe, on the South-East coast. The climate at this station is undoubtedly the most equable in the State, and it will compare favorably with any other part of the world.

Mr. G. M. Davidson, a well-known agriculturist of Canada, who visited South Australia during the winter of 1910, in the course of an interview with a representative of the press, remarked—"My visit has afforded me a great deal of pleasure and interest. What struck me most was the wonderful growth of vegetation, grass, and green fodder at this season, which is in striking contrast with the Canadian fall. Your climate is ideal when such conditions usher in the winter. To one used to the rigors of the snow and frost of the long winters of Canada your winter is a pleasant rainy season, with a gentle reminder that Jack Frost has not given up the ghost. This opinion would be shared by every Canadian if he only had a taste of its salubrity. I have had the benefit of seeing most of the rich agricultural lands and beauty spots of the South-East District, and they lead me to say that one could hardly wish for a better place to permanently settle or retire. The rich black soil shows great fertility and, if I might use a pleasantry, it seems to require only a tickling with the hoe to laugh itself into a harvest."

During the hottest months, January and February, the mean maxima temperature at Robe is only $72^{\circ}.8$ and $72^{\circ}.9$ respectively, whilst at Adelaide for a similar period the readings are respectively $86^{\circ}.6$ and $86^{\circ}.0$. With regard to the number of hot days (over 90°), the mean number of days at Robe for the whole summer is only four, whereas Port Lincoln experiences 11 hot days, Mount Barker 25, Adelaide 41, Port Augusta 59, and William Creek 98. The temperature over the highlands, especially the Mount Lofty Range, is much cooler than on the plains, particularly during the nights, which are nearly always cool and pleasant, even during a prolonged spell of heat. At Mount Barker, situated in the Mount Lofty Range, the mean of the night temperatures for January and February is about 9° below the Adelaide records.

The prevailing wind at Adelaide in the summer is south-west, blowing off the cool coastal regions into the heated interior, whilst during the winter the direction is reversed, and the wind blows from the north-east, the centre of the continent then being colder than the surrounding ocean.

A rainfall map issued by the Meteorological Department gives the average yearly rainfall throughout South Australia. In compiling the map only stations with at least 15 years' records have been used, and this necessarily restricted the number; but, as the selected stations are well distributed and representative, and cover on the average nearly 30 years, it may be fairly assumed that the isohyetal lines drawn on the chart are near the truth, and will not be materially altered by the rainfall of subsequent years; it should

be stated, however, that the trend of the 15in. line through the upper portion of the South-East District must be regarded as only an approximation, as but one station (Lameroo, and that with only 11 years' record) was available as a guide.

The main factors which determine the rainfall distribution of the State are the proximity of the Southern Ocean and the long extent of coastline exposed to the free and unrestricted sweep of the westerly trade rains; the rainfall over all the coastal areas is, therefore, essentially a winter one, and practically all available for agricultural purposes, as from 70 per cent. to 90 per cent. of the annual totals in the more settled areas falls during the growing period, April to October.

Though physiographic influence is less marked than in South-Eastern Australia, the effect of elevation is shown by the heavier rainfalls on the eastern sides of Spencer's Gulf and Gulf St. Vincent, and by the northerly extension of the 10-in. isohyetal from Port Augusta to beyond Blinman. The abundant rains on the Mount Lofty Range to the east of Adelaide are a conspicuous example of this, the annual total on the crest of the range reaching to nearly 47in.

Mean Annual Rainfall.

No.	District.	Mean Annual Fall.	No. of Stations used to get Mean.	Range.			
				Highest Yearly Average.		Lowest Yearly Average.	
				Station.	Amount	Station.	Amount
1	Far North and North-West Pastoral	7.53	17	In.	In.	In.	In.
2	Upper North (Agricultural Areas)	13.19	23	Blinman.....	12.85	Oodmanatta	4.76
4	Lower North " "	17.40	32	Melrose	23.04	Pt. Augusta West	9.36
3	North-East	8.45	5	Watervale.....	27.17	Port Pirie	13.21
6	Yorke Peninsula.....	16.51	13	Broken Hill ...	9.65	Waukaringa.....	7.94
7	Central Districts.....	23.97	54	Maitland	20.08	Ardrossan.....	13.89
9	Kangaroo Island.....	20.79	7	Stirling West	46.70	Stockport	15.89
5	West of Spencer's Gulf.....	15.38	34	Cape Borda	25.09	Kingscote	18.95
8	Murray Valley	12.20	17	Green Patch ..	26.56	White Well	9.67
10	South-East (Northern half)	17.60	8	Milang	16.08	Morgan	9.29
11	South-East (Southern half)	25.83	10	Bordertown	19.76	Cooke's Plains.....	11.74
				Mt. Gambier	32.00	Frances	20.74

(b) TIDAL PHENOMENA.

(By PROFESSOR R. W. CHAPMAN, M.A., and CAPTAIN A. INGLIS, F.R.A.S.)

ALONG the South Australian coast for the greater part of the month there are two tides a day, with a well-marked diurnal inequality. The morning tide is higher than the afternoon tide from about the middle of October until about the middle of February, and the afternoon tide is the higher during the other half of the year. The most notable peculiarity is what has been locally named the "dodging tide." At the neaps there is commonly no marked tide at all. In some cases the level of the water remains almost constant for a whole day ; in other cases there is one small tide during the day, and for a day or two on each side of this the tide is markedly irregular, both as regards time and height. The apparent impossibility of saying when high tide will occur at this period of the month has presumably gained for the tide its title of "the dodger." The harmonic analysis of the curves from the Port Adelaide tide gauge has shown that this is due to the remarkable fact that the principal semi-diurnal tides, due to the sun and moon, are here almost exactly equal to one another, the sun alone producing a semi-diurnal tide which would at Port Adelaide cause low water at noon almost exactly. The result is that at the neaps, when the solar and lunar tides are in opposition, one nullifies the effect of the other and no tide at all would result. This gives an opportunity for other diurnal tides, which are here relatively large, to produce effects which at other times of the month are masked by the more powerful solar and lunar semi-diurnals. An interesting theory has been put forward by Mr. Harris, of the United States Coast and Geodetic Survey, to account for the relatively large effect here produced by the sun. According to his computation the body of water between the south coast of Australia and Antarctica has a natural period of swing about a nodal line running east and west midway between the two continents of just six solar hours. The relatively large effect of the sun is thus accounted for by the synchronising of the natural period of swing of this basin of water with the period of the solar tide producing forces.

In travelling up the gulfs the tidal wave is propagated with greater speed along the deep water of the middle of the gulf than along the shallow at the sides. By the time the wave has reached the head of St. Vincent Gulf the co-tidal line is practically parallel with the coast line all round, so that the

wave reaches Port Wakefield at the head of the gulf at the same time as it reaches the Semaphore and Black Point at the sides, and the time of high water is the same at the three places. As the wave moves up the gradually narrowing gulf into shallower water its speed diminishes, but its height increases, so that the mean spring range of the water is 6ft. at Rapid Head, 8ft. 3in. at Port Adelaide, whilst at the head of the gulf at Port Wakefield the range is 11ft.

The Port Adelaide tides are now predicted by means of a special machine devised by Captain Inglis, the harbormaster.



View at Norton's Summit, 8 miles from Adelaide.



Rhododendrons and Japanese Maples in a Mount Lofty Garden.

BOTANY.

BY T. G. B. OSBORN, *Professor of Botany in the University of Adelaide.*

TO prepare, within the limits of a handbook article, an account of the flora of a State that ranges over 12° of latitude, including nearly 250,000,000 acres of land, receiving a rainfall which varies from 4in. to nearly 47in., is no easy matter. Nor is the matter simplified by the fact that much of the country is botanically, at any rate, unexplored. A further complication is the fact that the writer has had but little over a year in which to learn his country. It is hoped, however, that the following notes, with their illustrations, may be of use to visitors.

The value of this section is much increased by the special articles contributed by Dr. R. S. Rogers, on "Orchids," and Mr. J. M. Black, on the "Alien Plants," both of whom have for many years devoted much attention to their respective subjects.

GENERAL.

South Australia has not the richness of vegetation that characterises the wetter south and eastern portions of the Commonwealth, nor the tropical profusion of the Queensland flora, nor has it the variety of endemic species that are so remarkable a feature of the western State. The words of Hooker, in his introductory essay to the "Flora of Tasmania," still holds true, that the flora of "the country about Spencer's Gulf" is, in many respects, intermediate between that of the east and the west. According to Tate (1887 and 1890), there are recognisable in South Australia two distinct floras—the Eremian, or desert flora, characteristic of the north, and the Euronotian flora, which is dominant over the south-east parts of the continent, and which reaches its western limit in the agricultural areas of South Australia when it meets the Autochthonian or Western Australian flora.

The following table, compiled from Tate's "Flora of Extra-tropical South Australia," may be of interest in throwing some light on his contention. It

is, unfortunately, impossible to quote any more recent records : and subsequent work, such as that of J. H. Maiden, on the genera *Eucalyptus* and *Acacia* will have rendered some of the figures inaccurate, but it will not impair their relative value to any serious extent :—

Most Prominent Orders.	No. of Genera.			No. of Species.			Euronotian only.
	Total.	Eremian only.	Euronotian only.	Total.	Common to both Regions.	Eremian only.	
1. Composite ...	58	13	7	233	107	71	45
2. Leguminosae	44	22	5	225	47	109	69
3. Gramineæ ...	44	12	6	136	43	73	20
4. Cyperaceæ ...	15	3	3	94	23	25	46
5. Chenopodiaceæ	12	2	1	82	36	45	1
6. Myrtaceæ	11	—	2	77	15	17	45
7. Orchidaceæ ...	18	1	13	65	5	1	59
8. Goodeniaceæ .	9	2	1	50	13	27	10
9. Myoporineæ ..	2	—	—	46	8	33	5
10. Proteaceæ ...	18	—	6	40	4	17	19
11. Malvaceæ	8	3	1	39	8	28	3
12. Cruciferae	12	—	1	38	17	15	5

It is not, however, intended to attempt a floristic analysis of the South Australian flora, but rather to describe, as far as possible, certain of the more characteristic plant communities in the State.

SCLEROPHYLLOUS WOODLAND.

There are two chief regions in the State where the forests have typically an undergrowth of sclerophyllous bushes. The one is the Mount Lofty Ranges, extending south from the Adelaide district, the other is some 250 miles south, in the Mount Gambier district. In both regions the rainfall is high, about 25in. in each case (up to 40in. and over at Mount Lofty), but about 80 per cent. of it falls April-October. The typical sclerophyllous woodland about Adelaide occurs on sandstones and quartzite rocks of Pre-Cambrian age. The dominant trees are species of *Eucalyptus*. At the summits of the Mount Lofty Ranges the chief tree is *Eucalyptus obliqua*, the stringybark. Below this, *E. leucoxylon*, the blue gum; *E. viminalis*; and *E. odorata*, the peppermint, are all important. The various species appear to be affected in their distribution by the class of soil, thus *E. leucoxylon* is more often noticed on rocky soils than *E. odorata*, which more generally occurs in clayey soils that are often burnt hard in the summer. *E. rostrata*, the red gum, also occurs. This species is probably the most widely distributed in South Australia, but not the most numerous in point of individuals. It affects deep, well-watered spots and creek beds, where it may attain 100ft.

The trees in sclerophyllous woodland are rarely so close grown that their tops interlace. The ground between is occupied by a thick bushy flora that may reach 2m., but is more usually about half that height. These shrubs belong to a great number of families, though there is often a marked similarity of leaf form and habit. The leaves are usually small and simple, often hard and coriaceous in texture, and with acute spine-like points. Hairs are often absent or limited to the lower surface (*Banksia*). *Banksia* and *Hakea* (Prot.), *Acacia*, *Pultenea*, and *Viminaria* (Leg.), *Dodonaea* (Sapind.), *Spyridium* (Rhamn.), *Leptospermum* (Myrt.), and *Ixodia* (Comp.) are the chief genera. Species of these genera are all common, though frequently one or other of them will assume local importance. The ground between the bushes is covered by a multiplicity of small shrubby plants. Of the various families represented, the Leguminosae with species of *Acacia*, *Daviesia*, *Dillwynia*, *Eutaxia*, *Pultenea*, *Platylobium*, *Gompholobium*, *Kennedyia*, &c., is easily represented by the greatest number of species and often by individuals as well. Other important genera are *Griseolia*, *Isopogon* (Prot.), *Billardiera* (Pittos.), *Correa* (Rut.), *Tetrapetra* (Treman.), *Hibbertia* (Dillen.), *Calycothrix* (Myrt.), *Epacris* and *Styphelia* (Epac.), *Prostanthera* (Lab.), &c.

Various species of *Goodenia*, *Scaevola*, *Brunonia* (Gooden.) are common as low-growing herbs; also *Stylium*.

In the spring months many orchids make their appearance (see special article); also *Hypoxis glabella* (Amaryl.); and such Liliaceæ as *Chamaescilla*, *Bulbine*, *Caesia*, and later in the season *Burchardia*. Evergreen perennial liliaceous plants are *Dianella* and *Xanthorrhæa*, the grass tree. Often whole acres may be covered with this almost to the exclusion of other plants. *Pteridium* also prevails over large areas in the hills. Grasses are rare, species of *Stipa* being most common. Mention must also be made of the various species of *Drosera* that appear in the spring. Of these *D. Whittakeri* and *auriculata*, both bulbous forms, are most common.

The predominant color of the flowers is yellow, and in August, when the majority of the Acacias are in bloom, or a little later when the Papilionaceæ and Hibbertias flower, the landscape has often a golden hue. Notable exceptions to the yellow color are *Tetrapetra*, whose magenta-colored flowers are a feature of the hills in October and November; *Epacris impressa*, which has beautiful heath-like blooms of white, pink, and crimson; *Cheiranthera* (Pittos.), which has flowers of a rich blue color; or *Calycothrix*, which produces masses of small pinkish blooms.

The sclerophyllous woodland in the Mount Lofty Ranges is intersected by many deep valleys with precipitous sides known as gullies. These are often dry in the summer months, but in them is found some of the moistest ground in the district. The soil is a rich, black, sandy loam, rich in humus, but too



View in Morialta Falls Reserve.

The dominant trees are *Euc. leucoxylon*, with an undergrowth of sclerophyllous bushes. Note *Xanthorrhrea quadrangulata* on cliff to right.

well drained to be seriously acid. Such gullies are valuable for horticultural and market gardening purposes, so that in most of them readily accessible to a market the native vegetation is destroyed. Where it is left, the fresh water ti-tree (*Leptospermum lanigerum*) is characteristic, forming dense thickets of bushes up to 3m. to 4m. high. There are found such succulent native plants as *Ranunculus lappaceus*, *Viola hederacea*, and *betonicæfolia*, *Limnanthemum reniformis* (Gentian). Such ferns as *Adiantum*, *Lomaria* and *Lindsaya* occur in the moister places, as well as *Cheilanthes*, *Asplenium flabellifolium*, and *Grammitis rutacfolia* in the rocky sides.



View of Cherryville, Mount Lofty Ranges.

Specially typical of the rocky faces overhanging such valleys are *Casuarina quadrivalvis* and *Xanthorrhæa quadrangulata*. This species of *Xanthorrhæa* is arborescent, forming a trunk up to 2m. high, or even more, with a dense crown of wirelike leaves 1m. long and roughly 5cm. square. The trunks branch not infrequently, and the twisted trunks, blackened by fire that destroys the old leaves, have a most grotesque appearance (See plate on opposite page).

SAVANNAH FOREST.

Much of the forest land to the north of Adelaide following the ranges as far as Terowie (140 miles north) is classed as savannah forest; this type also occurs on Yorke's Peninsula (Tate, 1889) and Eyre's Peninsula (Tate, 1881). The dominant trees again are eucalypts. North of Adelaide

E. leucoxylon is especially important over large areas. The characteristic difference between vegetation of this type and that previously described is the presence of a grassy undergrowth and the relative absence of shrubs. In places, however, an underwood of *Acacia pyeanantha* (often 2m. high, with pendant phyllodes like eucalyptus leaves) covers large areas, and is artificially encouraged on account of the value of its bark for tanning. *Bursaria spinosa* (Pittos.) is also a shrub of common occurrence, whose lilac-like masses of white flowers are a feature of the woodland in early summer.



National Park, Belair.

The trees are chiefly *Euc. viminalis* and *E. rostrata*, the ground covering largely grasses and small herbs.

There is a marked periodicity in the vegetation. In the winter months after the rain has set in, from May onwards, the country is green with annual grasses and other herbs. These rapidly pass into flower and fruit, so that by the end of October or November the landscape has become a uniform brown color, destitute of flowers except for such ubiquitous plants as *Wahlenbergia gracilis* (Camp.) and *Convolvulus erubescens*. Set on such a brown ground the olivaceous green of the eucalyptus trees is specially striking.

GRASSLAND.

Comparatively little grassland exists in South Australia of which it may be said that trees did not grow there before the advent of civilisation. This is, of course, only to be expected, for the climate, with its hot summers

coming at the time of least rainfall, is essentially favorable to evergreen woodland. There is, however, an area of upland country lying about Burra (101 miles north of Adelaide) that has an average elevation of 1,600ft., and rises in a series of parallel ranges, running north and south, to hills that at Mount Bryan reach 3,000ft. The district lies largely within the 20in. isohyet, it experiences low winter temperatures, and at all times of the year is subject to strong winds. This country is almost destitute of trees except for occasional Casuarinas, which are found often in very exposed situations, growing along the quartz veins that follow the north and south trend of the hills. The hillsides and valleys have a thick, red loamy soil that forms rich wheat land, but until recently has been used almost exclusively for pastoral purposes. *Xerotes dura* (Liliac.) forms characteristic rush-like clumps over the hillsides. One of the principal native grasses is *Danthonia penicillata*, but the introduced *Bromus sterilis* and *Avena barbata* are common. The alien *Hordeum murinum* is extremely plentiful, especially on the level valley bottoms where the soil is rich in mineral salts. Various *Geraniaceæ* (spp. of *Geranium* and *Erodium*) are very characteristic herbs during the winter months.



Mallee Scrub—Pinnaroo District.

SCRUB.

The wide-spread occurrence of scrub is typical of hundreds of square miles of South Australia. This characteristic formation is composed of

numbers of bushes from 2m. to 4m. high which, viewed from a distance, form a monotonously regular covering to the gently undulating country. The vast majority of the bushes are species of *Eucalyptus* known collectively as "mallee." The term signifies a habit of growth rather resembling coppice. From a main underground root-stock there arise several stems that go to form a rounded bush. Some species of eucalypts appear consistently to show this habit of growth, as *E. calycogona*, *goniocalyx*, *incrassata*, and *oleosa*. On the other hand *E. odorata*, which in the hills forms trees 10m. to 12m. high or more, may form a mallee when growing under suitable conditions.

The ecological characters determining the prevalence of mallee country in South Australia have yet to be determined. It is noticeable that mallee scrub occurs on Yorke's Peninsula, with an average rainfall of about 17in., as well as on the mainland, with an even higher rainfall (e.g., Roseworthy, 19in.), while it is especially characteristic of the great tract of country bounded north and east by the Murray, known as the Ninety-mile Desert, much of which receives only 10in. to 15in. The soil in the latter region is light and sandy with a tendency to form surface deposits of travertine limestones and ironstones.

The mallee are in the majority of cases too far apart for their crowns to interlace, though in favored spots they form an impenetrable growth. Other large shrubs are various Melaleucas and *Callitris*, which latter forms trees 10m. or more. The twine-like parasitic stems of *Cassytha pubescens* and *C. melantha* are common in many places, almost smothering the plants on which they grow. In the more open places there are many low shrubs of *Dillwynia* (Legum.), *Dampiera* and *Prostanthera* (Lab.), *Eremophylla* (Myopor.), *Senecio*, and *Olearia*. Grasses are very few, various Stipas being the commonest, especially after a fire. There are, however, a large number of small annuals, such as *Helichrysum*, &c.

On sandy rises bushes of *Baeckea* (Myrt.), *Olearia* (Comp.), &c., may temporarily replace the Eucalypts. Especially characteristic of many of these ridges is the "broom mallee" *Exocarpos spartium* (Sant.), which forms a fastigiate leafless bush about 2m. high. Another noticeable plant is *Loudonia aurea* (Halor.), which is a beautiful sight in October and November with its almost leafless green stems and golden-winged fruits.

Another plant community that may be classed as scrub occurs on sandy country near the sea. Its chief tree is *Callitris propinqua*, associated with which are *Eucalyptus odorata*, and to a lesser degree *Casuarina quadrivalvis*. This pine wood was at one time common around Adelaide, but it is rapidly disappearing. The ground covering in spring is rich in such annuals as *Claytonia volubilis* (Portulac.), *Leewenhookia dubia* (Stylid.), and numerous small composites. Many of these are extremely small and very short lived, being excellent examples of ephemeral plants.

COASTAL.

The low sandy coast north of Adelaide in St. Vincent's Gulf and around the head of Spencer's Gulf is fringed by a belt of the mangrove, *Aricennia officinalis*. On the landward side this passes into a salt swamp composed chiefly of *Salicornia australis* and *S. arbuscula*, which latter forms bushes 1m. or more in height. *Samolus repens* (Prim.) and *Frankenia laevis* (Franken.) are also characteristic plants, though not confined to this community. *Melaleuca pustulata* (paper-bark ti-tree) forms dense thickets of bushes or low trees along salt creeks beyond the mangrove limit.



Virgin Land, Adelaide Plains.

The trees are chiefly *Callitris propinqua*, the ground covering *Mesembryanthemum aequilaterale* and ephemerals.

Much of the coast is fringed by low sandhills. *Atriplex cinereum* and *Cakile maritima* (introduced) are to be met with as strand plants. The chief sand-binder is *Spinifex hirsutus*, also *Mesembryanthemum aequilaterale* and *Scirpus nodosus*. These are all much inferior to the introduced *Amphphylla arenaria*, which is planted in the comparatively few places where the dunes cause trouble by their instability. Characteristic of the dune formation along the South Australian coast are various shrubby plants. Of these *Pimelia stricta* (Thymel.), *Styphelia Richei* (Epac.), *Scuterola crassifolia* (Gooden.), and *Olearia axillaris* (Comp.) are the most common, especially the last. *Fusanus acuminatum* and *Exocarpos stricta* also occur. *Lotus australis*, *Senecio lautus* and the introduced *Oenothera odorata* are common herbs.

Lepidosperma gladiatum and other cyperaceous plants cover large areas of the more settled dunes. The settled dunes readily pass into scrub composed of mallee or *Callitris*, *Casuarina*, &c.



View in Flinders Range—Far North of South Australia.

The lower slopes have forests of *Callitris robusta*. The plains are grassland, except for belt of *Euc. rostrata* by creek bed.

SUBMARINE.

The fine, sandy bottom of the shallow waters of St. Vincent Gulf and the more sheltered places along the South Australian coast are thickly colonised by such phanerogams as *Ruppia*, *Zostera*, and *Posidonia*. These form large meadows, and their *debris*, cast up after rough seas, lines the foreshore from Outer Harbor to Brighton with a belt of "sea weed" some yards across and 18in. to 2ft. deep. One of the most interesting plants in this formation is *Pectenella (Cymodocia) antarctica* (Black). The seeds of this plant germinate *in situ*, and when the seedling attains a length of 8 or 10 cms. it breaks away, still retaining at its base the four-lobed horny, comb-like outgrowth from the carpel wall which serves it as a grapple.



Memory Cove Tablet, Port Lincoln,

The mallee habit is well shown by the central eucalypt. Tussocks of *Stipa*: plants in foreground, *Mesembryanthemum aequilaterale*.

SALT-STEPPE.

Much of the vegetation in the districts north of the Murray, and approximately bounded by the 10in. rainfall line, is what is known as "saltbush". The typical saltbushes are species of *Atriplex* (especially *A. nummularia*) *Bassia*, *Kochia* and other chenopodiaceous plants. These form an open community together with scattered low trees of such plants as *Acacia cneura* (mulga),

Cassia, *Pittosporum*, *Myoporum*, &c. For much of the year the ground between the bushes is devoid of plant life, but after rain it rapidly becomes green with various grasses (*Panicum*, *Andropogon*, *Eragrostis*, &c.), as well as many annuals. Among these, various "everlastings" (*Helipterum* and *Helichrysum*) are very noticeable, as well as *Cianthus Dampieri*, the Sturt Pea.

It is, however, a mistake to suppose the whole of the country in the Far North to be desert. The Flinders Range, for instance, starts about the Broughton River, in $33^{\circ} 18'$ S. lat., and runs north for about 260 miles. The lower slopes of this are clothed with extensive forests of *Callitris robusta*, while the water-courses along the valleys are fringed by a belt of red gums, *Eucalyptus rostrata*, Acacias, &c. (See plate, page 260.)

The country north of Oodnadatta to the border of the Northern Territory forms a part of what has been termed the "lower steppes" (Spencer, 1896). Much of this is "gradually rising and somewhat undulating country, with low-lying, flat-topped hills and upland plains covered with 'gibbers'"—wind-smoothed stones. The "gibber" plains "merge constantly into loamy plains covered with poor scrub, but on which the 'gibbers' are wanting." The scrub is composed of Cassias, Eremophilas, Hakeas, and Grevilleas, all thinly scattered about. "On the loamy flats, and even 'gibber' plains, the most noticeable plant is *Salsola kali*, popularly known as 'rolly-poly'. It is when mature one of the characteristic prickly plants of the lower steppes, and forms great spherical masses perhaps a yard or more in diameter." There also occur tussocks of *Spinifex paradoxus*, scattered plants of *Euphorbia Drummondii* and *Ptilotus*. A single species often forms a pure colony over a considerable area. The lines of the water-courses are marked by belts of gum trees and Acacias, *Eucalyptus rostrata* and *E. microtheca*, *Acacia aneura* (mulga) and *A. hamalophylla*. In the dry season everything is parched, but after a heavy fall of rain a rich crop of grass appears and numerous flowers, among which clumps of the white-flowering Amaryllid (*Crinum flaccidum*) may cover acres. The Nardoo (*Marsilia quadrifolia*) is a feature of the clay water-pans in the wet season. It should be remembered that only about 40 per cent. of the rainfall (4.9 in. per an. at Oodnadatta) falls in the winter months.

ORCHIDS.*

General.—Orchidaceous plants are represented in South Australia by terrestrial forms only, the extremely dry climate and absence of deep valleys being unfavorable to the growth of epiphytes. A transitional form, *Dipodium punctatum* (Br.), which still has its epiphytic representatives in India and the Malay Archipelago, occurs in the Mount Lofty Ranges. This is a leafless species with a very extensive tuberous root system and a stem destitute of, or deficient in chlorophyll. It is generally supposed to be parasitic on the roots of eucalypts, although its connection with the latter has never been definitely demonstrated.

Distribution.—The distribution of the order is apparently governed by the average annual rainfall. A 10in. rainfall would appear to provide the minimum amount of moisture necessary for the maintenance of these plants. Their distribution is therefore chiefly coastal in character, and is limited to a comparatively small portion of this large State. Of the 90 species which have so far been recorded, probably not more than half this number are to be found more than a hundred miles north of Adelaide. Those which penetrate farthest into the interior belong to the genera *Caladenia*, *Thelymitra*, and *Pterostylis*. It seems remarkable that any member of the latter genus, the majority of whose species are so singularly adapted for shade and moisture, should ever acquire the physical characters necessary for an existence in these arid regions. They generally meet their xerophytic conditions by enlargement of their root-system, death of the leaves before flowering, and thickening of the stems. Hairs are not produced on the vegetative parts of the plant, and only in very limited numbers on the flowers themselves—chiefly on the labellum and margins of the galea. The Caladenias, with their somewhat woody stems and very hairy habit, are primarily better equipped for the rigid conditions under which they have to live, and maintain a hardy existence in the Far North with very few modifications. The few Thelymitras that reach these districts increase their root and reduce their leaf-systems, as in the case of *Pterostylis*. In no case do they develop hairs.

There is reason to believe that the tubers of these plants do not vegetate annually, but that during unusually dry seasons they miss the vegetative stage and lie dormant until more favorable conditions become established.

Owing to the geographical position of South Australia as the central State, it is hardly to be expected that any of its genera should be endemic. As a matter of fact, out of the 19 indigenous genera, no less than 15 are shared in common with all the other States; three do not extend into Western Australia, but are distributed over other parts of the continent; and the remaining

* Contributed by Dr. R. S. Rogers.

one extends from the Swan River in Western Australia along the southern coast to Port Phillip in Victoria. There is, therefore, no genus found exclusively in this State.

Ten of our genera have a wide climatic range and extend into the Australian tropics; eight are peculiar to Australia; 11 are represented in New Zealand; seven extend into New Caledonia, the Malay or Eastern Archipelago, or to the East Indies; one reaches Southern China; and one (*Spiranthes*) is a cosmopolitan genus found in many parts of the globe.

The accompanying table shows the distribution of indigenous genera and their relative strength in species over the various States in the Commonwealth.

Table showing Distribution of South Australian Genera with Corresponding Number of Species in various States of the Commonwealth.

Genera.	Western Australia.	South Australia.	Victoria.	Tasmania.	New South Wales.	Queensland.
Dipodium	—	1	1	1	1	2
Thelymitra	17	14	9	8	10	2
Calochilus	1	1	2	1	3	2
Diuris	6	7	7	5	17	9
Orthoceras	—	1	1	1	1	1
Cryptostylis ...	1	1	2	1	3	2
Prasophyllum ..	15	14	15	12	23	7
Spiranthes	—	1	1	1	1	1
Microritis.....	7	4	3	2	2	2
Pterostylis	9	17	21	16	26	16
Caleana	1	2	3	2	2	2
Acianthus	1	2	2	3	3	2
Cyrtostylis	1	1	1	1	1	1
Glossodia	3	1	2	1	2	2
Hyperanthus ...	3	1	2	2	3	1
Eriochilus	4	1	1	1	1	1
Leptoceras	1	1	1	—	—	—
Caladenia	28	18	12	12	15	5
Corysanthes ...	1	1	2	4	3	2

Endemic species are more numerous than might be supposed. The limitations of our knowledge may be partly responsible for this, and a more complete botanical survey may reduce the number. At present it stands at 19.

Of the remaining species, 20 have almost certainly been derived from the western part of the Continent. Thirty-two of our species have apparently come to us from Eastern Australia, and two have probably drifted down from the Malay Archipelago to the eastern and western coasts, and so become dispersed over the whole continent.

In the case of 16 species the evidence is inconclusive as to their place of origin and direction of migration.

Species are shared in common with the other States as follows:—Victoria, 67; Tasmania, 58; New South Wales, 54; Queensland, 37; and Western Australia, 32.

Tribes and Principal Genera.—With the exception of *Dipodium*, which is the sole representative of the tribe Vandeæ, all South Australian orchids belong to the Neottieæ.

Dipodium is provided with the usual lid-like anther of its tribe. The pollen-masses are waxy, two in number, globular and each very shallowly bilobed. There is no true caudicle, but each mass when released from the anther drops on, or becomes adherent to the free extremity of a process (stipes) projecting from the back of the rostellum. During dehiscence the anther-case becomes hardened, and is usually shed as soon as the pollinia are liberated.

Among the Neottieæ there are several genera of more than passing interest.

The complex modification of the third petal so as to form the labellum, is a feature of such almost universal occurrence amongst orchids that the retention of this petal in practically an unmodified condition is worthy of attention. This occurs in *Thelymitra*, a genus well represented in this State.

Prasophyllum is interesting on account of the resupination of the flowers and the wide range in stature that occurs among the different species. They constitute at the same time our most minute and our tallest orchids. Two of the former are leafless plants, only 2in. or 3in. in height, and bearing minute flowers, whereas *P. elatum* may reach a height of 3ft. 6in. or more.

Pterostylis is characterised by the green color of the flowers in most of the species, and by the fact that the lateral petals and dorsal sepal have become dove-tailed together so as to form a conspicuous hood or "galea" over the gynostemium. The lateral sepals are always united in a greater or lesser portion of their length so as to form an erect or reflexed lip in front of the galea. Nearly all members of this family are provided with a highly irritable labellum, which plays an important part in the mechanism of pollination.

Caleana, like the *Prasophyllums*, has resupinated flowers and, as in the case of *Pterostylis*, the labellum is sensitive.

Caladenia is probably our largest and most widely distributed genus. The leaf and stem are very hairy, and the labellum (the margins of which are

frequently toothed or fringed) has its surface studded with stalked or sessile glands (known as calli) arranged in various ways upon the lamina. The family includes the so-called "spiders," and is probably the most showy and beautiful of our genera.

Diuris, although comprising only seven species, is very prolific, and probably one of the best known families. All its members are glabrous plants with long narrow leaves, short column, and deeply divided tripartite labellum.

Propagation.—The mechanism for pollination is exceedingly elaborate in many of our orchids, nevertheless the fact remains that a great proportion of them depend for their propagation very largely upon vegetative reproduction. In certain genera (such as *Caladenia*, *Microlis*, *Prasophyllum*, and *Thelymitra*) capsules are produced freely, and seeds are shed in countless numbers. Some of these seeds doubtless survive and germinate, but the vast proportion of them must perish. Many attempts have been made to cultivate them artificially, but so far as the writer can ascertain such attempts have been unsuccessful. Very little indeed is known about this mode of propagation. It has been observed, however, that during seasons following extensive bush fires, the hills become veritably carpeted with orchids, many of the species being comparatively rare at other times. The plants are far too numerous to be accounted for by stimulation of the buried tubers, and the probable explanation appears to be that the fires have created conditions favorable for the germination of seeds dormant from former seasons. It might have been supposed that such fierce conflagrations would have destroyed these minute bodies, but apparently they become covered over and are stimulated to increased vitality by the chemical products of the burnt forests. Certain species hardly ever bloom, except after a bush fire. This is notably the case with *Lyperanthus nigricans* and *Prasophyllum gracile*.

In some genera, seed capsules are produced with comparative infrequency. Few orchids, for example, possess a more highly specialised mechanism for pollination than *Pterostylis*, yet very few capsules are produced by some members of that family, the mode of propagation being chiefly by that of vegetative reproduction by tubers. This is also the case in *Cyrtostylis*, where the plants are prolific and grow in colonies. It is possible that a set of conditions may arise unfavorable to such a mode of propagation, but favorable to reproduction by seed in the case of these and similar families. The mechanism of pollination would then be of real practical utility to the plant. Under any circumstances a few capsules seem to be produced every season, and these probably contain sufficient seed to ensure the perpetuation of the species, should the conditions be such as to result in the failure of the root system.

ALIEN PLANTS IN SOUTH AUSTRALIA.*

Australia presents peculiar advantages for distinguishing between native and foreign plants, because some of the earliest expeditions to her shores carried capable botanists. Sir Joseph Banks and Dr. Solander (of Cook's first voyage), Labillardiere (of D'Entrecasteaux expedition), and Robert Brown (who accompanied Flinders) are cases in point. Still there are some species about which it will always be doubtful whether they are endemic or were introduced inadvertently by the earliest colonists. Speaking of these aliens, "met with by the first explorers of inland districts, under conditions which precluded any idea of recent introduction," Bentham says in the preface to the last volume of the "Flora Australiensis," "The appearance of these plants in Australia is in some instances not readily explained."

Among such species of disputed origin may be quoted *Emex australis*, whose troublesome spiny fruits are known in South Australia as "prickly jacks." It was discovered along the coast near Adelaide and Glenelg (where it is still common), about 1850 by Mueller, and in West Australia by Drummond a few years earlier. These dates, however, allow ample time for the introduction of the plant from its home in South Africa. The same argument may be used with greater force in the case of the sea rocket (*Cakile maritima*), which Baron von Mueller classed as a native, although it was not recorded in Victoria until 1869, and then not far from Melbourne. It has certainly spread rapidly, and it is now common along the coasts of South Australia. Horehound (*Marrubium vulgare*) has been found so far afield in new pastoral country that bushmen insist on considering it a native, although this is doubtless a mistake.

Two species of *Gomphocarpus* (*G. arborescens* and *G. fruticosus*) grow freely along the foothills of the Mount Lofty Range, and have so much the aspect of Australian shrubs that they are commonly regarded as natives. It is mentioned, however, by Allan Cunningham in 1817 that *G. fruticosus* had been introduced into New South Wales several years previously as an ornamental plant and had gone wild. Both species are called "cotton bush" in South Australia, on account of the hairy-tufted seeds, although in their own country (South Africa) they are said to bear the popular name of "milk bushes," from the milky juice contained in its branches. It is noteworthy that Cape plants, which have become naturalised in Australia, have usually a less alien aspect than the intruders from Europe or America. Mr. F. S. Salisbury, an English botanist, who also spent some two years in Adelaide and wrote several interesting articles on our local flora, has recently published a "List of Grahamstown Weeds," and emphasizes how closely the aliens of South Africa correspond with those of Australia. For instance, the only mallows proper

* Contributed by Mr. J. M. Black.

which have been brought into South Australia are *Malva niceensis* and *M. parviflora*, and just these two European species are found growing near Grahamstown in Cape Colony.

The possibility of the variation or hybridization of European species in Australia is an interesting problem for elucidation. Some facts seem to point in this direction. Observers who have had experience in both continents consider that the two sow thistles (*Sonchus oleraceus*, L., and *S. asper*, All.) run into each other much more closely in Australia than in Europe. Then in the group of goosefoots (*Chenopodium album*, L., *Ch. ficifolium*, Smith, and *Ch. opulifolium*, Schrad.) there is often in South Australia a mixture of forms which defies satisfactory analysis. The contradictory determinations which have been made of Australian specimens forwarded to great European herbaria go to prove that the difficulty is a real one.

The manner in which vigorous aliens are replacing native growths becomes more remarkable every year. The former have for centuries battled against the plough, the hoe, the attacks of sheep, cattle, rabbits, &c., and have developed powers of resistance and a viability which the endemic plants of Australia do not possess. In the neighborhood of towns the grasses and other annuals and biennials are almost entirely alien. Canary broom (*Cytisus canariensis*, Steud.) has escaped from hedges in the Mount Lofty Ranges and, advancing in a dense mass, stifles the native shrubs and takes their place. A graceful shrub of South America (*Nicotiana glauca*), the "palán-palán" of that country and known as "tobacco-tree" in Australia, has spread to the most distant cattle runs, and is just now causing discussion as to whether it is a pest on account of its poisonous properties when eaten in large quantities, or a benefit to the land as a sand-binder.

It is not only European growths which supplant the Australian; South Africans also have a superior vitality, and this again may be due to the fact that they have had throughout the ages to contend with animals larger and more aggressive than the kangaroo and the wallaby. The fig marigold of the Cape (*Mesembryanthemum acinaciforme*) has escaped from gardens and occasionally meets our native species, locally called "pigface" (*M. aequilaterale*) on the sandhills near the coast. Where this occurs the fact that it is on its native soil is no protection to the Australian, which is soon surrounded and stifled by the intruder. Exactly the same contrast is found between the highly-aggressive foreign bindweed (*Convolvulus arvensis*), which has been recently introduced, and the shy and retiring *Convolvulus erubescens* of Australia, although some forms of the native plant so closely resemble the alien that discrimination is difficult. In the agricultural districts the public roads, usually one chain wide, form an invaluable refuge for native shrubs, at least for a time, in country which was clothed with scrub before the advent of the farmer or fruitgrower.

As long ago as 1859 Dr. J. D. Hooker observed that while many European plants had become naturalised in Australia, no Australian plant had become naturalised in England. The number of small native plants which reappear on cultivated land or maintain themselves on pasture is very limited. One that seems to possess unusual power of accommodation to circumstances is a composite, *Vittadinia australis*. This variable species is also found in New Zealand and probably in South America.

The number of alien plants more or less naturalised and propagating themselves spontaneously in South Australia cannot to-day be less than 400. Of these it is probable that 300 are permanently established. About 100 are from the Mediterranean region, with which we have so many climatic affinities, and which has furnished some of the most aggressive immigrants. *Indigofera georgeana*, locally called "stinkwort," reached South Australia by some means over half a century ago. This sticky, strong-scented annual infests cultivated land after the crop has been removed, and gives a bright green tinge to the landscape, suggestive of some useful fodder plant. Beginning in wheat fields near Adelaide it has now reached the farthest northern limits of cultivation in this State, and has circled eastward round Australia, until it has passed beyond Sydney. Another ubiquitous introduction is the *Oxalis cornuta* of South Africa, an ornamental plant which must have escaped from cultivation in early colonial days. Strange vagaries of distribution sometimes occur. Two Mediterranean grasses, *Trisetum pumilum* and *Eragrostis minor* have recently been discovered in our far interior, although they have never been noticed in the coastal districts.

LITERATURE.

The following selection of literature bearing on the South Australian flora may be found useful :—

Black, J. M., 1909.—"Naturalised Flora of South Australia." Contains 368 species with notes on their country of origin and distribution in the State.

Maiden, J. H., 1907.—"A Century of Botanical Endeavour in South Australia." Presidential address, Section D; Aust. Ass. Adv. of Sci., Adelaide Meeting, p. 158. An historical account of exploration and investigation, together with a bibliography.

Schomburgk, R., 1876.—"Flora of South Australia," in Harens's "Handbook of South Australia," pp. 205-280. Is chiefly important for its account of the vegetation which is divided into forest, scrub, and grass land (pp. 211-219); quoted largely by Schimper, A. F. W., "Plant Geography," and Diels, L., "Die Pflanzenwelt von West Australien."

Spencer, Baldwin, 1896.—"Report on the Work of the Horn Scientific Expedition to Central Australia," Part I. Introduction, Narrative, Summary

of results, &c. Though the greater part of the country traversed is now in the Northern Territory the narrative and summary are most valuable for their account of the steppe vegetation and are full of observations on the ecology and growth conditions of Central Australian plants.

Tate, R., 1880.—“Census of the Indigenous Flowering Plants and Ferns of Extra-tropical South Australia.” Trans. Roy. Soc., S.A., vol. III, p. 46. First division of flora according to geographical regions.

Tate, R., 1881.—“The Characteristic Vegetation about Franklin Harbor.” *Ibid.*, vol. IV., p. 137. Short notes distinguishing littoral vegetation (mangrove sandhill), mallee on sandy soil (“pliocene drift”), and savannah upon slate hills.

Tate, R., 1883.—“The Botany of Kangaroo Island,” *Ibid.*, vol. 6, p. 116. Contains valuable notes upon climate, geology, and “prominent groups of vegetation,” as well as list of spp., and a discussion on the origin of the flora.

Tate, R., 1887.—“On the Influence of Physiographic Changes on the Distribution of Life in Australia.” Presidential address, Section D., Austr. Ass. Adv. of Sci., Sydney, vol. I., p. 312. Divides flora into immigrant and endemic elements, chiefly concerned in the latter especially the Eremian, which is centred round Lake Eyre, S.A.

Tate, R., 1889.—“The Geological and Botanical Features of Southern Yorke’s Peninsula.” Trans. Roy. Soc., S.A., vol. XIII., p. 112. Yorke’s Peninsula is divided by a transverse salt marsh regarded as a deserted seaway. The northern part is savannah with *Casuarina* and scattered small trees of *Eucalyptus*, *Pittosporum*, &c. The southern is chiefly mallee scrub.

Tate, R., 1890.—“Handbook of the Flora of Extra-tropical South Australia.” Contains map and definitions of geographic regions, as well as a census of distribution.

Tate, R., 1896.—“Report on the Work of the Horn Scientific Expedition to Central Australia.” Part III. Geology and Botany. Deals chiefly with the Larapintine Flora (Finke River basin), which is in the Northern Territory, but has an account of the central Eremian flora of the Far North of S.A.

Tepper, O., 1880.—“On the Characters and Distribution of the Native and Naturalised Plants about Ardrossan.” Trans. Roy. Soc., S.A., vol. III., p. 25. Notes on habitat and relation of plants to geological formations, also list of spp., identified by von Mueller.

PTERIDOPHYTA.

The climate of South Australia, with its prolonged dry season, is not suitable to the growth of fern plants. Moreover the absence of deep, shady valleys is an additional cause for their scarcity. Bush fires and the spread of cultivation have done much to reduce the numbers of ferns even in the districts with

the most favored rainfall. Three species of *Lycopodium* are recorded, but they are limited to the southern part of the ranges, except for *L. laterale* that extends to Kangaroo Island. Two *Selaginellas* are also recorded (*S. Preisiana* and *S. idiginosa*), the latter being limited to the extreme South-East. None of the *Lycopodiaceæ* are common, however, their infrequency being in marked distinction to the Eastern States.

Ophioglossum vulgatum has the second widest distribution of any of the ferns, being recorded from almost all districts in the State. *Botrychium ternatum* has also been found in the Mount Lofty Ranges.

Dicksonia antarctica was recorded from the Mount Lofty Ranges, and also from Mount Gambier in the South-East, but Tate in 1890 notes that it is probably extinct in the State. *Todea africana* is also stated to occur in the Mount Lofty Ranges, and in Schomburgk's time (1876) to have formed impenetrable thickets in gullies which now are probably market gardens. Specimens are rare, and there can be no doubt that this too will share the fate of *Dicksonia*.

It is from the gullies of the Mount Lofty Ranges that the majority of the ferns are recorded. Of these the commoner are *Asplenium flabellifolium*, with its long rachis extended beyond the pinnae; *Grammitis rufa*, which is common in rock crevices and extends even to the Far North; *Lomaria capensis* and *Adiantum Ethisopicum*, the maiden hair. This last may produce fronds 42 cms. or more when growing in gully bottoms under the shelter of bushes or bracken amongst grass. *Gleichenia circinata* (coral fern), at one time was so common as to be used as bedding for cattle, but it is now rare in the Mount Lofty Ranges. Other genera recorded are *Schizea*, *Lindsaya*, about Adelaide, *Aspidium molle* from the Murray, and *A. decompositum* and *Polypodium punctatum* from the South-East.

Pteridium aquilinum occurs frequently in the ranges from Adelaide to Victor Harbor. On the sandy soil of the South-East it often covers hundreds of acres of open country, as well as forming the chief undergrowth of the forests.

The genus *Cheilanthes* is represented by four species, of which *C. tenuifolia* ranges over the whole State, extending from the Northern Territory to the extreme South-East. It is common on all rocky slopes in the Mount Lofty Ranges, and even extends on to the plains. *Cheilanthes velutina* is a species with a pronounced hairy covering of the lower surface of the pinnae that occurs throughout the North and Far Northern areas into the Territory.

The *Hydropteridæ* are represented by three genera. *Pilularia globulifera* is only recorded from the North, but *Marsilia* (the Nardoo) ranges from the Far Interior, where it is common in waterholes during the wet seasons, to Adelaide; it also occurs in the South-East. *Azolla* is common on the Murray, where it is known as "duckweed."

BRYOPHYTA.

The *Bryophyta* of South Australia have, so far as I am aware, received little attention at the hands of collectors. The Transactions of the Royal Society of South Australia (vol. 4., p. 5, 1881) contains a single list of specimens collected by Baron von Mueller. The list comprises but 36 species of *Musci* and six species of *Hepaticæ*. Though this must be far short of the full number, the dryness of the climate and absence of deep, moist valleys is probably responsible for the marked infrequency of these plants throughout the State in comparison with the eastern coast of the continent.

ALGÆ.

The fresh-water *Algae* of the State are at present an unexplored field. The Charales are a solitary exception. Specimens were sent to Alex. Braun by von Mueller, the list being published in 1881 (Trans. Roy. Soc., S.A., vol. 4, p. 6). There are three species of *Chara* recorded and four of *Nitella*. *Chara australis* is common in most slow streams where there is a more or less constant water supply. The marine *Algae* have been collected more frequently. Sonder identified 273 species submitted by von Mueller (Trans. Roy. Soc., S.A., vol. 4, p. 13). Since then two further lists have been published, one of 272 species, obtained at Lacepede and Guichen Bays by Dr. Engelhart and identified by Reinbold (*La Nuova Notarisia*, ser. VIII, 1897, and ser. IX, 1898). A further collection of 117 species was made by Miss Davey in Investigator Strait, and also identified by Reinbold (*Hedwégia*, vol. 38, 1899).

FUNGI.

(See also pp. 186-9, *ante* "Notes on Plant Pathology.")

The fungus flora of South Australia has been much less worked than that of some of the other States, notably that of Victoria, where the indefatigable energy of Mr. MacAlpine has done much to advance our knowledge. The only summary of information published regarding the fungus species occurring in this State since Cooke's "Australian Fungi," is McAlpine's "Systematic Arrangement of Australian Fungi," 1895, supplemented by a further paper (Report Aus. Ass. Adv. Sei., 1898). The *Uredineæ* and *Ustilagineæ* have received special treatment in McAlpine's "Rusts of Australia," 1906, and "Smuts of Australia," 1910.

The number of species recorded for South Australia is only about 300, but this must be very far from complete in all groups, especially in the smaller forms which naturally have received less attention from collectors. At present South Australia has only some 12 per cent. of the total number of species

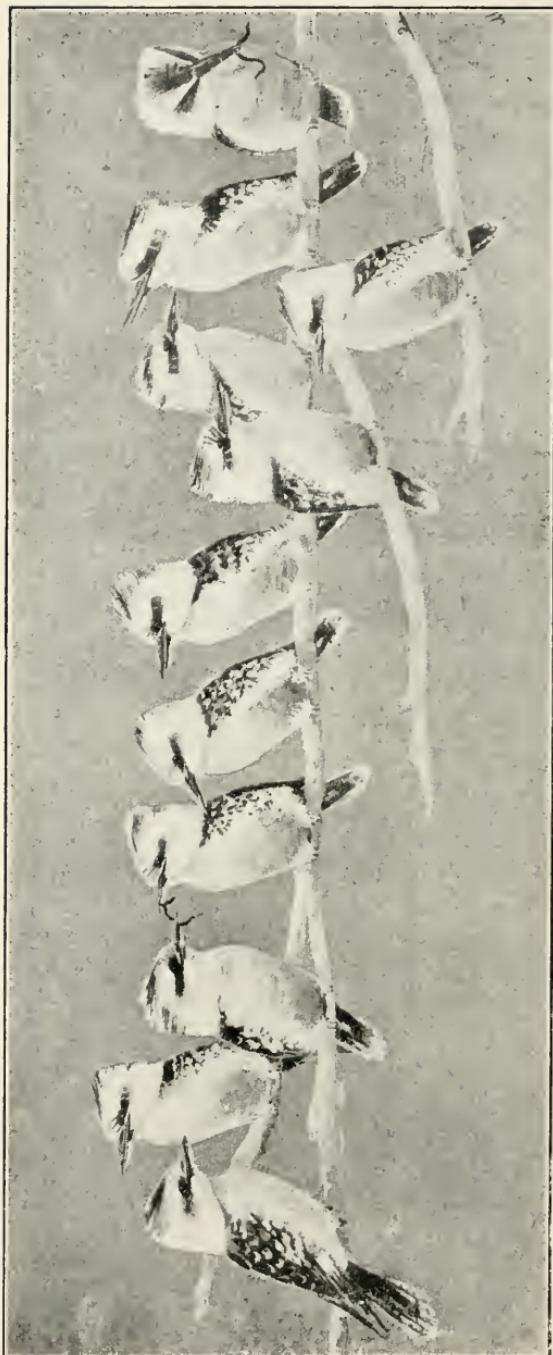
recorded for the Commonwealth. The following figures, giving the numbers of species recorded, are taken from McAlpine's works, and brought up to date as far as possible by more recent records. Their chief value is to show how little mycological work has hitherto been undertaken in the State : *Myxomycetes*, 2 ; *Phycomycetes*, 3 ; *Ascomycetes*—*Discomycetes*, 10, and *Pyrenomycetes*, 18 ; *Fungi Imperfecti*, 30 ; *Hemibasidiomycetes*, 17 ; *Protobasidiomycetes*, 26 ; *Autobasidiomycetes*—*Hymenomycetes*, 151, and *Gasteromycetes*, 26.

Among the more remarkable fungi occurring in this State the following may be mentioned :—*Pleurotus camelsceens*, F.v. M. and Berk., is a member of the *Agaricinæ*, of common occurrence on dead eucalyptus stumps in the hills district. The gills are luminous for a period that may last as long as a week about the time of maturity of the pileus. The luminosity is dependent on the life of the fungus, it is destroyed at death, and is independent of exposure to light.

Polyporus mylittæ, Cooke, produces bulky sclerotia, which were formerly known as *Mylitta australis*, beneath the surface of the ground in many districts. Sporophores have developed from these after they have been collected on several occasions.

McAlpine and Tepper have described a fungus belonging to the *Polyporeæ* under the name of *Laccocephalum basilapiloïdes* from the mallee country. The mycelium forms an accretion of the sandy soil on which it grows at the base of the centrally-placed stipe. These stony masses are roughly egg-shaped and may be as much as 12cm. long and 8·5cm. in the greatest diameter.

The first specimen of the remarkable genus of the *Uredineæ*, *Uromycladium*, was found in this State in 1889, but was described as a *Uromyces*. It was not till 1905 that McAlpine described the new genus. Both gall-forming species (*U. notabile* (Ludw.), McAlp., and *U. Tepperianus* (Sacc.), McAlp.) occur commonly in the State, and form large galls on the acacias infected.



An Australian Eleven

Koalahumus (*Dactylopsilus gigas*).

(From a painting by Miss Mabel Boothby, Adelaide.)

BIRDS.

BY CAPT. S. A. WHITE, M.B.O.U.

FROM an ornithological point of view South Australia stands out from all the other States of the Commonwealth, as this State divides the island continent—the east from the west—and within its boundaries the overlapping or inoculation of the eastern and western birds takes place. From this point alone the State would be considered by ornithologists of the greatest importance, but there are other conditions to be taken into consideration. For example, South Australia presents a fair stretch of coastline to the Southern Ocean. Within this coastal area, and of course good average rainfall, the Mount Lofty and other ranges are situated. A greater part of these ranges, as well as the adjacent plains, are covered with fine eucalypt forests, which supply food and shelter for many of the more brilliant plumaged birds, as well as the more sombre and rarer bird life. There is an absence of the damp, tree-fern clad gullies of the Dandenong Ranges or the Australian Alps—the home of Menuridae or Lyre Birds—still the deep gullies of the Mount Lofty Ranges are clothed in a dense and varied vegetation, which in its turn shelters many strange and rare forms of bird life. Such secluded shelter is afforded the avifauna of these ranges that without doubt there are still rare and new species to be discovered and added to the long list of science, for nearly every year some new species is brought to light.

Leaving the coastline and travelling north a drier and more open country is reached. Vast saltbush plains are met with similar to the Karoo of South Africa. As the country changes so do many forms of bird life. The coloration of the plumage becomes lighter and lighter as the more arid regions of the interior are approached, and in many cases a very conspicuous reddish tinge prevails. This latter coloration is in harmony with the general aspect of the country. This is Nature's plan for protection. The White-bellied Plume Pigeon, commonly known as the Rock Pigeon (*Lophophaps plumifera leucogaster*), when sitting on the reddish-brown rocks of the interior cannot be discerned at 20yds. if it keep motionless. Many species of bright-plumaged birds do not modify their dress to their environments—such as the maluride Wrens. The gorgeous livery of the male birds is far more striking amidst the very sombre and stunted vegetation of the interior than when he is at home in the heart of the rich green vegetation of the coastal area. Yet the

birds found in the interior are just as vivid in coloration—if not more so—than those found amidst the fern-clad ranges of the coast. Out of some 900 species of birds known to Australia over 400 are found in South Australia. Many of these are found in the adjacent States, and others are distributed over nearly the whole of the Commonwealth. Yet there are some peculiar to the State of South Australia, and there is little doubt that there are many more to be discovered, because vast tracts of country in the interior have never been worked by the ornithologists.

Kangaroo Island, situated at the entrance to the Gulf of St. Vincent, although only divided from the mainland at one place by Backstairs Passage, which is eight miles across, is the home of many species of bird life, as well as plants not found anywhere else in Australia. This is remarkable when we find many of these island birds are of strong flight, for instance, the Kangaroo Island Glossy Cockatoo, a fine black bird with a wide scarlet band across the tail. These birds have not been seen on the mainland, and from observations made keep to the western end of the island. Yet a closely allied bird, the Black Cockatoo, which has yellow markings instead of red, passes backwards and forwards from the mainland to the island. Much of the country in this State, both in the east and in the west, is covered by a thickly growing eucalypt known as mallee, and here is the home of one of the greatest enigmas amongst bird-life, the Mallee Fowl (*Leipoa ocellata*). These strange birds form a natural incubator, that is, they scratch a great quantity of loose earth, sand, and debris into a conical-shaped mound. This is about 3ft. in height, and contains about 200 cub. ft. of material. A cavity is left in the centre of the mound, and into this some months before the time for laying a quantity of leaves and other vegetation is placed, and the winter rains give this material a thorough soaking. When the sun provides additional warmth in the spring decomposition sets in and heat is generated. The hen bird scratches a layer of sand and levels it down, lays her first egg, which is of enormous size in comparison to the bird. The egg is taken by one claw and placed on end, the smaller end always being downwards. The sand is scraped round the egg by the bird's bill till it stands upright, then completely covered with sand and loose earth. Next day the nest is opened up, the sand scratched out, and another egg placed alongside the first, and this is continued every third or fourth day till the first layer is completed. Then another one is started on top of the first, after placing a layer of sand or loam between. After the Mallee Fowl has finished laying she comes to the nest or incubator every fourth or fifth day and loosens up the soil round the eggs to see if there be too much heat, and from this wonderful trait in these birds' character they derive the name of "Thermometer Birds." The eggs being phenomenally large the chicks are also large and strong, and as soon as they are hatched,

they start to make their way out of the mound quite unassisted, and by the time they have accomplished the passage through the warm, friable earth and debris to the outer world, their feathers are quite dry. They can fly a great distance, and are so fleet of foot that one has no chance of catching them. The adult birds are very shy, and if they have the least suspicion that they are being watched will not go near the nesting mound. All the material used in the construction of the mound is scratched up by the birds' feet, then swept along by their wings as they run up the side of the mound, and after nesting time the birds' wings present a very worn appearance.

Since the advent of artificial manures much of the mallee country has been taken up, cleared, and put under plough, and in other parts the country is being stocked, so each year these strange birds are being driven farther and farther back, and will in time, like many other strange animals, be exterminated. Through the efforts of the South Australian Ornithological Association a number of these birds have been liberated on Kangaroo Island, where they are safe from many of their enemies, the chief of which is the imported fox.

No country in the world is so well represented in the parrot family as Australasia, and South Australia has her share of these wonderful and beautiful birds. There is the Black Cockatoo of the south (*Calyptorhynchus funereus xanthanotus*). This is a fine bird of large extent of wing, the yellow markings of the tail feathers showing up in strong relief to the remaining black plumage of the bird. Then there is the Black Cockatoo (*Calyptorhynchus banksii stillatus*) of the interior about the same size, of black plumage, only where the yellow band crosses the tail feathers of the former species this bird is adorned with a wide band of scarlet. Both belong to a strange family of birds which have a small body, large expanse of wing, huge head provided with a most wonderfully powerful bill, and long tail; their cry is a very discordant one and can be distinguished from any other family of cockatoos very readily, and even each species has its own distinctive call. Next to the



Black Cockatoo
(*Calyptorhynchus-funereus*).

Black Cockatoos comes the White Cockatoo (*Cacatua galerita*), a fine bird of snow-white plumage, and adorned with a sulphur yellow crest. These birds are sought after as pets, and are often seen in cages or chained to stands, and are great experts at talking and whistling.

Closely allied to the last species comes the Pink Cockatoo (*Cucatoes leadbeateri*), a most beautiful bird of salmon pink plumage and white wings, crest barred with deep red and yellow. This bird is mostly confined to the interior, and is seldom seen near the coastal areas. In strongly contrasting and brilliant plumage, the Rose-breasted Cockatoo (*Cucatoes roseicapilla*) excels all the other South Australian cockatoos. This bird, which is somewhat smaller than the foregoing species, is known to the settlers by the familiar name of "Galah." Its wings, tail, and back are of a beautiful shade of French grey, and the remainder of the plumage a bright rose pink. These birds often congregate in thousands, and when rising from the ground (where they feed), sometimes hundreds on the wing at the same time, and a strong sunlight playing on their plumage, present a gorgeous sight.



Curlew or Stone Plover (*Burhinus-grallarius*) Squatting.

Amidst the fine timber of the Murray banks the ornithologist can study the habits of the beautiful Black-tailed Parrot (*Polytelis anthopeplus*); black tail and wings, coral-red bill, and the rest of the body bright yellow, is a coloration vastly striking. In noticeable contrast to the last species, the Kangaroo Island Crimson Parrot (*Platycercus elegans melanopterus*), a bird with bright blue cheeks and crimson body, makes a striking object in the bushland. Then again, amidst our Mount Lofty Ranges we have a lovely bird in the Adelaide Rosella (*Platycercus elegans adelaide*), so named by John Gould (the father of Australian ornithology) in 1840. Amidst the mallee country a gaily-plumaged parrot lives; its livery consists of yellow and green, and by the settlers is called the Mallee Parrot or Ringneck (*Platycercus barnardi*); they

make excellent cage birds and whistle well. Another very beautiful bird is the Yellow-banded Parrot (*Platycercus zonareus*), which is found on Eyre's Peninsula, and also in the vast region of Central Australia. Wherever water exists in the centre of our continent these lovely birds are found to relieve the great monotony of their surroundings, for they are a large parrot with black head and yellow collar; the rest of the body is bright green, with the exception of a bright yellow band across the breast.

The genus *Psephotus* is a family of beautiful grass parrots. First there is the many-colored parrot (*Psephotus varius*), so named from the many colors by which its body is adorned. The Blue-vented Parrot (*Psephotus bourkii*) is another charming bird, whose home is the vast interior. It was named after Bourke, the explorer, who lost his life in the great lone land where the bird is found. A strange little parrot, called the Rock Parrot (*Psephotus petrophilus zietzi*), has its home along the rocky shores and islands of this State, where it lays its eggs and rears its young in the cracks and crevices of the rocks. One of the well-known birds of the State is the Shell Parrot or Love Bird (*Melopsittacus undulatus*), a beautiful little creature of elegant shape and resplendent in its garb of grass green, with yellow and blue markings. These birds prefer the drier parts, and in the vast interior congregate at rockholes and other watering places morning and evening. It is a sight to behold a flight of several hundreds of these birds coming in to water at sunrise.

Amongst the most wonderful of Australian parrots is the Night Parrot (*Geopsittacus occidentalis*). This strange bird lives in the centre and western part of Australia. In the centre of the State much country is covered with porcupine or spinifex grass, which grows in bunches and has a very sharp lance-like point to every leaf. In this shelter the Night Parrot sleeps all day and at night comes out to feed and drink. It has never been known to alight on a tree. When flushed from its hiding-place during the day time it only rises a few feet over the grass and drops to earth very soon again, and is lost amidst the prickly cover. This bird is fast disappearing, and will soon be a bird of the past.

The brush-tongued lorikeets play an important part amidst the bird life of South Australia, and the first amongst them, the Blue-bellied, or often called the Blue Mountain Lorikeet (*Trichoglossus novahollandiae cyrei, matthews*) is the most beautiful of its tribe, and should be called the Rainbow Lorikeet, from the number of brilliant colors which adorn it. Other species of this family, smaller but of bright plumage, are often found feeding on the honey-laden flowers of the gum trees. Prominent among them are the Purple-crowned Lorikeet (*Glossopsitta porphyrocephala*) and the Little Lorikeet (*G. pusilla*).

This brief sketch can hardly touch the fringe of wonderful bird life of the State, but it is well to note that the honey-eaters, for which Australia is so renowned, are well represented in this State, and there is hardly a locality that the ornithologist can visit where he will not find some species or the other of these interesting birds. Even on the bleak wind-swept coast or on the small islands, some mere rocks situated miles from the coast, is found the most beautiful songster amid this family of birds—the Singing Honey-eater (*Ptilotis sonora*), of sombre plumage but beautiful song. The Honey-eaters vary much in size and coloration, but in the latter green and yellow predominate. Another conspicuous bird is the Wren (*Malurus*). There are about eight species of these lovely little birds in South Australia, and they are distributed from the coastline to the dry interior. Amongst some of the most beautiful (of course in every case the male bird is richly adorned by Nature, for his mate is of a sombre brown color) there is the White-winged Wren (*Malurus cyanotus*), of bright-blue body and white wings, which has a vast range nearly all over the State. The Turquoise Wren (*Malurus melanotus, callainus*) and the Darker Turquoise Wren (*M. melanotus whitei*) are very like each other, having the head and mantle bright metallic blue, throat and abdomen dark cobalt blue, back and band across the breast black. Then there is *Malurus lamberti asimilis*, the Blue-breasted Wren, which is a combination of red, blue, white, black, and brown.

Space will not permit reference to many wonderful phases of bird life, for our rivers, lakes, and lagoons are the homes of most interesting water fowl, The forest trees, the home of tree creepers, Pardalotes, Shrike Tits, and many other species. On the plains, Stone Plover, Spurwing Plover, Banded Plover, quail of several species, larks, and ground birds of many kinds. Amidst the bush country finches of most gorgeous plumage are found, and often two or three species of swallows can be seen flying overhead.

Although the greater part of South Australia has but a light rainfall, still the State compares favorably with most countries in bird life, both in species and numbers.



Boobook Owl (*Ninox-boobook*).

ABORIGINES.

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THE Australian aborigines, from a general and anthropological point of view, will be dealt with in the Handbook prepared for the meeting of the British Association in Australia by the Federal Government. This article will deal chiefly with matters relating to the care and control of the aborigines in the State of South Australia.

Since the transfer of the Northern Territory from this State to the Commonwealth, which took place on January 1st, 1911, the native question, so far as South Australia is concerned, has in great measure changed its aspect. From being a problem involving the control of a relatively large number of natives, for the most part pure-blooded and living after their own customs in a more or less wild state, inhabiting wide areas which are very sparsely settled, or even almost unexplored, and at a great distance from the central government, the principal problem remaining for South Australia has now become one in which the chief difficulties are of another character. Now, these centre round the control, education, and destiny of a relatively small number of full-blooded aborigines and a relatively large number of half-castes and other grades of intercrossing between the white and native race, or between the latter and Asiatic aliens, such as Afghans and Chinese. The majority of such hybrids, moreover, are to be found in more or less well settled districts.

There still remain, it is true, even in the territory now left to South Australia, a not inconsiderable number of nomadic groups of full-blooded aborigines who continue to live after the native manner. A certain, though probably small, proportion of these live in still unsettled parts, and, coming rarely in contact with the whites, little is known of them. The majority are to be found in districts which, though for the most part sparsely settled, are well known. Of this last category the numbers are rapidly diminishing, and this is particularly the case where contact with white influence is continuous or frequent, as is the case on the northern transcontinental telegraph line, or where, as in the MacDonnell Ranges, discoveries of gold have brought an influx of whites. In such localities, as invariably, alcohol, zymotic and contagious diseases have wrought their deadly work, though, happily, opium has as yet gained no footing in South Australia as it has done in Queensland and the Northern



Plate I.

Territory. With these wandering groups, especially in the proximity of white settlements, are associated a number of half-castes or other hybrids who live the lives of the ordinary natives.

Thus, now, for South Australia one of the most pressing problems is that of the hybrids. The problem, though a general one for the State, has presented itself most obviously in connection with certain institutions, known as mission stations, some particulars of which will be shortly given. These missions have been founded and maintained, with or without Government assistance, by various charitable or religious bodies, and, for many years, they have taken under their control a considerable number of natives of whom the majority now consists of various grades of hybrids. One of these mission stations (Point McLeay) has received very considerable contributions from the Government, but all of them have hitherto been free from any Government control or supervision.

THE STATE ABORIGINES DEPARTMENT.

For the control of the South Australian aborigines, outside the scope of the mission stations, there exists a State Aborigines Department, of which the chief executive officer (now Mr. W. G. South) has the title of Chief Protector of Aborigines. His department works under a special Act of Parliament (No. 1048 of 1911) and its official head is, at present, the Commissioner of Public Works, though the reason for this Ministerial association is not obvious. Under the Chief Protector is the Inspector of Police at Port Augusta, who, with the title Protector of Aborigines, has some very limited powers and functions in connection with the natives of the northern areas. It should be understood that the Aborigines Department and the Chief Protector only have control of the natives outside the mission stations. These are, as has been said, free from Government control, though they may, and some of them do, receive a certain amount of financial, or other assistance from this quarter.

THE ABORIGINAL MISSION STATIONS.

POINT MCLEAY.

This was established by, and is vested in, the 'Aborigines' Friends Association,' and it comprises an area of 6,554 acres, situated on Lakes Alexandrina and Albert, and on the Coorong. This association was founded in 1858 and incorporated in 1879, and its principal aims were, at its foundation, set forth as follows :—

- (1) To instruct the natives in such industrial pursuits as may make them useful on the land, and enable them to earn their own living.

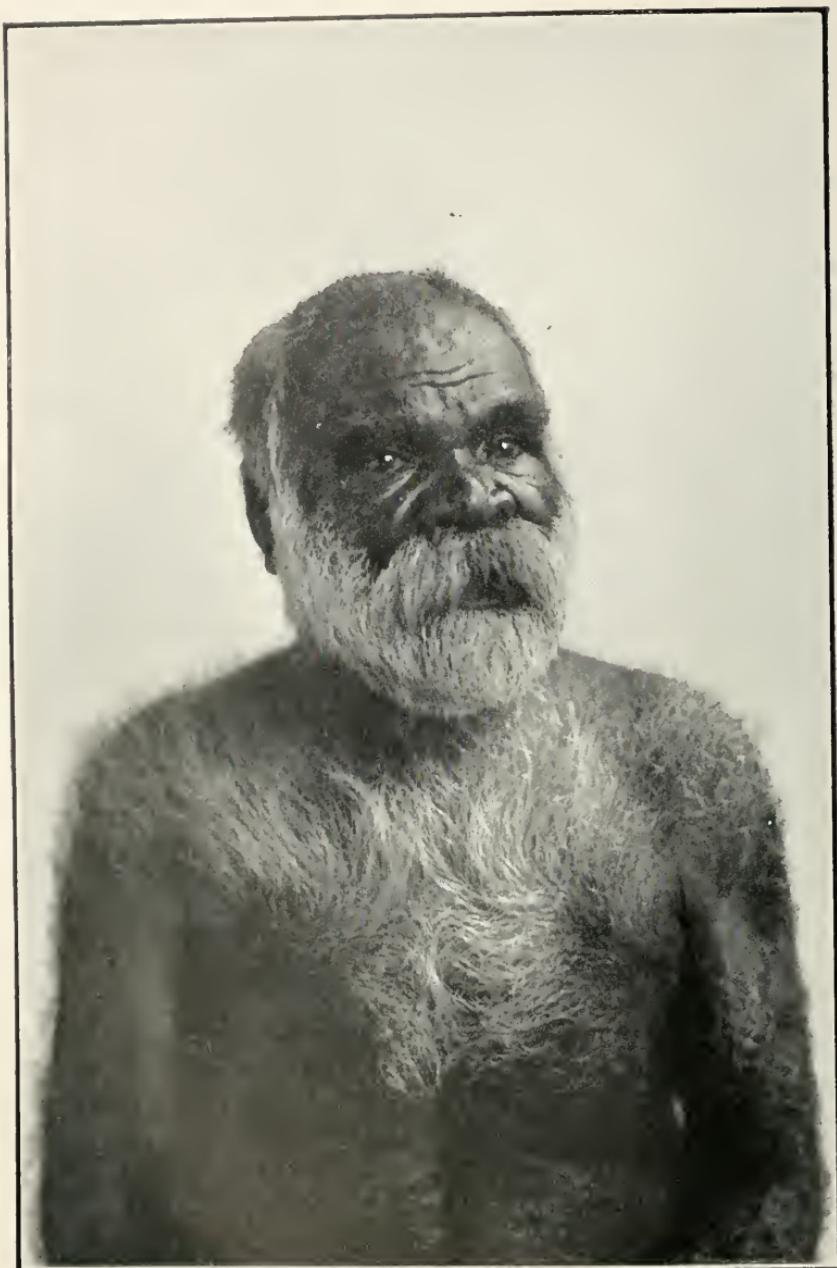


Plate II.

- (2) To encourage and assist native families in forming civilised homes.
- (3) To instruct them in the doctrines, precepts, and duties of the Christian religion.
- (4) To maintain a boarding school where the children may receive, gratuitously, the ordinary elements of an English education, and be trained in civilized habits.

This mission, which is the largest in respect to the native population under its charge, has generally received an annual Government grant of £1,000, which has occasionally been increased to £1,500, and for the year 1912-13, the total grant-in-aid was £2,128. The grant is conditional upon the raising of a certain sum by private contributions, which in 1912 amounted to £257.

In spite, however, of the liberal Government assistance the mission has not been a success financially. This has been, in part, due to the fact that the land used by the mission is insufficient in area and too poor in quality to produce a revenue adequate to support the number of its charges.

The Point McLeay Mission is managed by a resident superintendent and a committee of the parent society who give their services gratuitously. A State school is maintained in connection with the institution.

POINT PIERCE.

Founded by, and under the control of, the "Yorke Peninsula Aboriginal Mission," and managed gratuitously by a committee of six. The mission is situated on Yorke Peninsula, in the hundred of Kilkerran, and includes Wardang or Wauraltee Island. It comprises 17.298 acres (leasehold), about 7,000 acres consisting of arable land, of which area about 3,000 acres are put under crop each year. Point Pierce has received no Government assistance, except a few blankets, occasionally, for aged and infirm natives. By its farming and grazing operations it is self supporting, the revenue being partly derived from the cultivation of 1,000 acres by the native population, chiefly half-castes, and partly from the proceeds of the cultivation of 2,000 acres, on the share system, by neighboring farmers, in which work the natives take no part. Attention is given to the moral education and discipline of its charges and there is a State school in connection with the mission.

KILLALPANINNA.

Founded and maintained by the "Mission of the Evangelical Lutheran Immanuel Synod" and situated on the lake of the same name, about 50 miles to the east of Lake Eyre. It comprises a leasehold of 750 square miles, for which an annual rental of £5 is paid to the Government. The mission is worked as a sheep, cattle, and horse station, and it receives no money grant

from the Government, except some rations and blankets for the aged, sick, infirm, and children. The natives are trained in station work, and it maintains its own school.

KOONIBBA.

Founded and maintained by the "Mission of the Evangelical Lutheran Synod in Australia on the West Coast." It comprises 17,300 acres of land held under right of purchase, and of this area 12,700 acres are at Denial Bay,



Plate III.

West Coast, and 4,600 acres at Davenport Creek, 28 miles distant from the former holding. The mission derives its revenue from combined farming and grazing operations, and it receives no money grant from the Government though some assistance is given in the form of rations and blankets for the aged, sick, and infirm. It undertakes the education and training of the natives and conducts a school of its own.

Besides the four mission stations mentioned there existed, for about 10 years antecedently to 1911, a privately managed institution for the aborigines at Manunka, on the River Murray, a few miles above Chucka Bend. This

comprised 40 acres of leasehold land. For some years Manunka received a contribution of rations from the Government, but as the management and methods were not considered efficient these ceased and the station was closed.

The following table gives the native population dependent on the existing mission stations on June, 1914, the number of children, the births and deaths during the year at each, and the cost to the State for that year. The figures have been supplied by the superintendents of the missions through the Chief Protector :—

Name of Station.	No. of Full-blooded Natives.	No. of Half-castes and other Hybrids.	Total.	No. of Children (included in Totals).	Births.	Deaths.	Cost to the State, Including Grant-in-aid.
Point McLeay.	67	301	368	136	9	6	£2,158
Point Pierce ..	17	165	182	83	4	1	15
Killalpaninna.	115	14	129	23	3	3	160
Koonibba ...	81	47	128	43	2	1	231
	280	527	807	285	18	11	£2,564

The above figures have been definitely ascertained, but with regard to the total black and hybrid population of the whole State no reliable statistics exist, the censuses of 1901 and 1911 having been very incomplete in this respect. The Chief Protector, however, who has had opportunities of forming an opinion, that is, at least, more reliable than the returns of the official censuses, estimates the total number of full-blooded natives in the State at about 4,000, while of hybrids of all degrees at least 836 are known by the Protector to exist and he considers that there are probably 100 more of the latter category scattered throughout the State that have not come under his notice.

In round numbers, then, the total aboriginal and hybrid population of South Australia at the present date may be reckoned at about 5,000.

If we deduct from the figures given the numbers of each category in charge of the mission stations there remain about 3,720 full-blooded natives and 300-400 hybrids outside these institutions and under the direct control of the Aborigines Department.

THE WORK OF THE MISSIONS.

Reviewing, now, very briefly the work of the South Australian missions in the light of their system and policy, it may be said of all of them that they have earnestly and honestly labored within their means to improve the lot of their charges. It may be admitted that their intentions have for the

most part been beyond reproach. Further, so far as their missionary and educational work, and their efforts to improve the moral outlook are concerned, they may be considered to have achieved not a little success.

Their failure—and the failure is common to all of them—lies in the fact that their organisation and methods, and, one should add, their means, include no systematic and adequate provisions for carrying out the objects defined in the first of the aims set forth above as guiding the work of the Point



Plate IV.

McLeay Mission. In other words no adequate provision is made in the work of the missions for the industrial or other useful careers of their charges subsequent to the school-going age.

A certain limited number of the inmates do find more or less continuous employment in the work of the missions themselves, others, speaking now particularly of Point McLeay, find occasional work on neighboring privately owned sheep and cattle stations, drifting back on its conclusion to a life of idleness at, or near, the mission, which is unable to find profitable or useful work for all its charges; others again, with the characteristic native aversion

from continuous labor of any kind, live lazy lives on such contributions as are obtainable from the missions or from the bounty of charitable persons.

So far as Point McLeay is concerned some excuse may be found in the insufficiency or unsuitability of its land provisions or, in short, in the inadequacy of its means to give work to all its able-bodied inmates. The fact, however, remains that its system as hitherto carried out has contained no efficient scheme for providing its native charges, full-blooded and half-castes, male and female, with useful careers as, for instance, in agricultural, industrial, or domestic pursuits. By such means the early training in regular habits might be continued and the qualities of industry and thrift created and encouraged. For those who have been found incorrigibly lazy some means must be found of making them work which should not in itself prove an insuperable problem.

It is from the absence of such provisions that there have grown up in connection with Point McLeay a number of able-bodied natives of various grades of color who hang about the station in idleness, or at any other place where food and clothing can be obtained without effort.

While everyone will admit that the utmost benevolence should be shown towards the diminishing numbers of pure-blooded natives, many of whom are old or infirm, no good reason can be found for exempting the able-bodied half-castes, who in varying degrees approximate to the whites, from the necessity of earning their livelihood like other physically capable men.

Another important phase of the half-caste problem is presented by the children, and especially by the female children belonging to this category, and living with the native groups who either wander about or plant themselves in the vicinity of white settlements. These, being outside the missions come under the direct jurisdiction of the Aborigines Department. For these girl children, and particularly for those approaching adolescence, the moral atmosphere of native camp life is degrading in the extreme, and it would seem obvious in their future interests that as many of them as possible should be rescued at an early age from their unsavoury surroundings.

Certain limited powers of reclamation in this direction are possessed by the State Children's Council under the clauses relating to neglected children, but without particular reference to the aborigines. To a certain extent, however, it is found the powers of the council are hampered by the sentimental, though very natural, objections raised against the compulsory removal of native half-caste children from their black mothers, who in most cases are fond of them, and who, according to their lights, do the best they can for their offspring. Still, in view of the gratifying success that has attended the adoption and training of such children by the State Children's Council, it would seem

that the violation of the maternal feelings under such circumstances is a less evil than the physical and moral degradation which inevitably attends these girls if left under the influences of native camp life.

Thus far it has been made to appear that the mission stations have alone been to blame for the failure to find a completely satisfactory solution of certain aspects of the native problem, and, in this connection, Point McLeay, from its long standing, relatively large native population, and comparative



Plate V.

proximity to Adelaide has incurred the bulk of the unfavorable criticism that has been directed against the results of the mission system of management generally. In fairness, however to these societies it must be admitted that the Government department, which exercises its regime over a larger number of natives than the missions, has been no more successful than they in those matters for which the missions have been blamed. On the other hand, it must also be admitted that the roving bands of semi-wild or semi-civilized natives with their admixture of half-castes, scattered as they are over a vast

extent of sparsely settled territory, present to the Government department problems of a more difficult nature than do the compact, if mixed, bodies of natives congregated for the most part in organised institutions to the missions.

ROYAL COMMISSION ON THE ABORIGINES.

The recognition of the fact that the existing policies and systems both of the Government and of the privately managed associations had failed to deal satisfactorily with certain aspects of the aboriginal question, some of which have here been mentioned, led to the appointment, in the Parliamentary Session of 1912, of a Royal Commission of inquiry. This Commission, composed of members of both Legislative Houses, sat during 1913 and presented a progress report at the close of the Session of that year. It examined, exhaustively, a number of witnesses well qualified to speak on the subject, visited the Point McLeay and Point Pierce Missions, and extended the range of its inquiries by visiting New South Wales and Queensland.

In its progress report, which was adopted by the legislature, a number of recommendations for reforms were made, many of them being designed to meet the adverse criticisms which have been raised against the existing system and its results. Thus far, however, none of them have been carried into effect and, indeed, some of them will require legislative sanction.

The fundamental recommendations of the report are that the Point McLeay and Point Pierce Mission Stations shall be taken over by the Government from March, 1914, and be controlled by a board of six members, consisting of the Chairman of the State Children's Council, the Director of Agriculture, the Chairmen of the Point McLeay and Point Pierce Missions, and two other members appointed by the Government. The report also recommends that the present Chief Protector of Aborigines be the secretary and chief executive officer of this board.

The recommendations also include provisions for compelling the able-bodied half castes, quadroons, and octofoots to go into outside employment wherever possible, though the mission stations may be looked upon as their homes for the present; for the segregation, as far as possible, of the hybrids from the full-blooded natives; for the compulsory training of boys on the mission stations in trades and general farm work, and of girls in sewing, dressmaking, household duties, and laundry work, so that they may become fit for outside situations. Other recommendations are that the experiment be made of settling one or two of the most capable and best trained natives at Point McLeay and Point Pierce on small farms in the proximity of each of these stations, the Government providing the farm equipment, and the native occupiers to carry out their operations under the supervision of the board; that a system be adopted of keeping savings bank accounts at the stations

similar to that in practice in Queensland with a view of encouraging habits of thrift and of providing a small amount of capital to enable natives to start on their own account ; that the work of the State Children's Department in rescuing destitute aboriginal children be extended, and that the board have power to take control at the age of 10 years of any children whose environment is not conducive of their welfare.



Plate VI.

The missions are to be given every opportunity of continuing their missionary work, and, as Point McLeay is not capable of carrying its present population, it is recommended that a sub-station be established in new and undeveloped country near the River Murray, and that the half-castes be transferred thither so as to relieve the pressure at Point McLeay.

The Commission announce their intention to complete their work by visits to Killalpaninna and Koonibba.

This programme, at least, constitutes an honest and reasonable attempt to improve the lot of the natives by removing the principal defects of the present system.

Moreover, if the policy, as outlined in the recommendations of the Commission, be carried out it may be hoped that it will have the effect of postponing the extinction of the native race in South Australia for some time longer than now seems probable. Further, it will mean that the half-castes and other hybrids will, in the course of time, merge into the general white population. It need not, however, be feared that this process of miscegenation, which is bound to occur in any case, and under any system, will present the same social and other difficulties that have become so formidable in America and, to some extent, in South Africa. For the Australian race is not sufficiently numerous, virile, or prolific to raise problems of this kind ; and, for the half-castes themselves, the merging of a lower into a higher civilization offers the best solution of the difficulties which now surround them.

NATIVE TRIBES OF SOUTH AUSTRALIA.

Though, as previously stated, it is not the object of this article to deal comprehensively with the aborigines yet it may be appropriate in a local handbook to give some information—now largely a matter of history—as to the distribution of the native tribes of the State.

The early settlers found the plains on which Adelaide now stands occupied by natives said to have been not very numerous and not unfriendly to the whites. These constituted what was known as the Adelaide tribe, though the native name does not seem to have been handed down. This tribe became extinct about 1850, and, unfortunately, very little of their handiwork and few of their remains have been preserved. So, also, almost complete extinction has been the fate of the natives extending from Adelaide southward to the sea, eastward to the River Murray, and northward to the latitude of Port Augusta. A very few only of full-blooded individuals of the Narrang-ga tribe of Yorke Peninsula still survive, and the same may be said of the Parnkallas, who inhabited the Port Lincoln district extending up the eastern side of Eyre Peninsula. Most of the small surviving remnants of these tribes, as well as a very few from the near northern districts, make their home at Point Pierce.

The principal localities in South Australia at which any considerable number of aborigines are now to be found are the following :—There still live on the southern side of Lake Alexandrina a certain number of full-blooded natives of the tribe generally known as the Narrinyeri. But though this word is invariably used by the whites as a tribal designation it really has not this significance. The real meaning of the word is “belonging to men” in the sense that these natives considered themselves as men *par excellence* in contradistinction to other natives whom the Narrinyeri considered as inferior beings. The word is now generally taken by the Narrinyeri natives themselves



Plate No. VII.

to mean their own black race as opposed to that of the whites. The territory of the Narrinyeri extended from a little below Murray Bridge to Kingston in the South-East, and included all the shores of the fresh water Lakes Alexandrina and Albert and of the Coorong—an exceptionally well-favored region in the olden days in the matter of food supplies. This tribe was divided into 18 local divisions, or clans, each having its own territorial distribution, and, in the early days of the State, they, collectively, formed a powerful community, whose numbers, in 1840, were estimated at 3,000. In any case the very numerous camping and burial grounds and immense shell mounds that are found all along the lake shores and river banks indicate a once very numerous native population. This tribe came into evil notoriety early in the history of the State, as the perpetrators of the murder of Captain Barker at the Murray Mouth, in 1831, and of the whole of the crew and passengers of the wrecked ship *Maria*, at Lacepede Bay, in 1840.

Between 1830 and 1835, or a few years before the foundation of the State, the Narrinyeri, as well as the Adelaide and other native tribes of South Australia, were visited by a virulent epidemic of small pox, which reached them from the Eastern States *via* the River Murray and caused an enormous mortality, not only amongst the tribes of this State, but throughout the whole of Australia. Plate I. gives the portrait of a very old woman of this tribe who was the last survivor of those who actually suffered from the epidemic which is still spoken of by the older natives as a terrible calamity affecting their race.

It is members of the Narrinyeri tribe who, with their half-castes, almost exclusively constitute the native population of Point McLeay and who are occasionally seen in Adelaide.

Another centre where there are still a considerable number of full-blooded natives is the region around Lake Eyre, where there are, on the west side, the Urabunna and on the east a group of several associated tribes of which the Dieri is the best known. Killalpaninna derives its native population from this group of tribes, particularly from those on the eastern side amongst which the station is situated.

Stretching northward from Oodnadatta, the terminus of the Northern Railway, approximately along the tract traversed by the overland telegraph line, and reaching to a point about 50 miles north of the MacDonnell Ranges is the large area of country, about 300 miles long, occupied by the various sections of the once great Arunta tribe. Since the transfer of the Northern Territory the southern section only of the tribe come under the jurisdiction of South Australia. Though a considerable number of these natives still survive, frequent or constant contact with the whites along the telegraph

line and main northern route has led to a great diminution of their numbers, and to the discontinuance of many of their interesting native customs and ceremonies, of which so much has been written.

To the west of the Aruntas, and occupying an unknown area, though this includes the Musgrave Range, is the Luritcha tribe, of which we have comparatively little information.

In the Gawler Ranges district to the north of Eyre Peninsula there are still a certain but unknown number of natives, and, on the west side of this peninsula, extending in the same direction along the coastal regions of the Great Bight, come in succession the Nauo, Tidni or Hilleri, and the Mining or Yerkla-Miung tribes, the last named reaching to the Western Australian border. The Koonibba mission is in the Tidni country whence it no doubt draws the majority of its inmates.

From the coast line between Denial Bay and the western boundary of South Australia, northward to its northern boundary, is a little known and, for the greater part, waterless country, though it has been frequently crossed by exploring expeditions. These have generally met with bands of natives, especially in the more favored localities possessing permanent waters, but little is known of their numbers or of their tribal distribution. Those occupying the southern part of this large area will soon become better known as the result of the construction of the East-West overland railway line now in progress, and will no doubt suffer the usual fate in consequence.

In the extreme South-East of South Australia, adjoining the southern limits of the Narrinyeri were formerly a group of five tribes, now extinct, or practically so, of which the Buandik, occupying the Mount Gambier district, was the best known.

SUGGESTED TRANSFER OF THE ABORIGINES TO THE COMMON- WEALTH GOVERNMENT

Though only concerning South Australia by way of its exclusion a very brief reference may be made to a recent proposal, which is supported by many who have an intimate knowledge of the subject, that the native question in Australia might be most effectively solved by placing the aborigines under the Federal Government. This recommendation emanated from a committee appointed by the Australasian Association for the Advancement of Science at its Sydney meeting in January, 1911. The report of the committee was adopted at the succeeding meeting of the association in Melbourne, 1913, and forwarded to the Federal Government. Included amongst the recommendations was one exempting the natives of New South Wales, Victoria, and South Australia from this transfer, on the grounds that the restricted

numbers in these States are well cared for by their respective Governments, and that they present a later phase of the aboriginal question than do those of Queensland, Western Australia, and the Northern Territory with their larger native populations living in a more or less wild state.

So far, however, these recommendations have not been adopted either by the Commonwealth or by the States concerned.

EXPLANATION OF PLATES.

PLATE I.—Jenny Pongie; native name *Clul-lul-lowrie*.

A very old woman of the Narrinyeri tribe, believed to have been between 95 and 100 years of age at the time of her death at Poltalloch, Lake Alexandrina, on the 30th June, 1911.

She was the last survivor of her tribe who bore pock marks resulting from a severe epidemic of smallpox which devastated the Narrinyeri between 1830 and 1835, she being a grown woman at the time of its occurrence.

From a photograph by Mr. J. Marshall, 1908, lent by Mr. G. C. Haeket, of Narrung, Lake Albert.

PLATE II.—Kūlmaterie, aged about 60 years.

A man of the Narrinyeri tribe. This man is a good example of the condition known as hypertrichosis, or excessive hairiness, which is not uncommon amongst the Australian aborigines.

PLATE III.—Ada Walker; native name *Nildalli*.

An elderly woman of the Murray River. She shows to a marked degree the condition of hypertrichosis in a female. See Plate II.

From a photograph by Mr. W. Lingwood Smith.

PLATE IV.—Mary Beck; native name *Cunda*.

A woman of the Murray River.

From a photograph by Mr. W. Lingwood Smith.

PLATE V.—Yendinna Jack.

A native of Fowler's Bay. This man was hanged at Fowler's Bay in August, 1903, for the murder of an aboriginal.

From a photograph by Mr. W. Lingwood Smith.

PLATE VI.—Wonjirikara.

A native of the Port Augusta district.

From a photograph by Mr. W. Lingwood Smith.

PLATE VII.

Group of half-caste native children from various localities in South Australia, committed to the care of the State Children's Council.

From a photograph supplied by the secretary of that department.



A Donkey Team in the Far North.



Transportation in Central Australia is by means of Camel "Trains."

EXPLORERS AND THEIR WORK.

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[From the "Central State," by David J. Gordon.]

AUSTRALIA owes a big debt to the men who filled in the map of our island continent. In that work South Australia has been a generous contributor in men and money. The journals in which the leaders of the various expeditions sent out from this State recorded their sufferings and achievements are full of thrilling narratives of brave deeds. The names of the men who devoted the best years of their lives in making pathways for posterity through a continent will be honored so long as the inhabitants of the Commonwealth preserve the spirit and ideals which inspired our heroic pioneer colonists. South Australians have reason to take a special interest in this branch of Australian history, because several of the most notable and brilliant explorers were intimately associated with this State, and accomplished much of their work within its borders. For many years after the first immigrants landed on these shores some of the shrewdest and most intelligent of them held the opinion that a great lake or inland sea would eventually be found somewhere near the centre of the continent. Not a few of the ablest explorers cherished the hope that they would be fortunate enough to be the first Europeans to set foot upon the shores of an Australian Mediterranean. Flinders was familiar with the theory, and when his vessel was lying at anchor near the entrance to Spencer Gulf, he wrote in his journal—"Large rivers, deep inlets, inland seas, and passages into the Gulf of Carpentaria were terms frequently used in our conversation of this evening, and the prospect of making an interesting discovery seemed to have infused new life and vigor into every man in the ship." Nearly 30 years later, when Captain Sturt landed in Sydney, the belief in the inland sea hypothesis had been greatly strengthened by the results of the exploratory work accomplished during the interval. The greater part of the immense coast line of Australia had been more or less carefully scrutinised, but by a strange coincidence both English and French navigators who visited Encounter Bay in 1802 failed to detect the mouth of the Murray River in the long line of sandhills behind those threatening breakers which dash unceasingly upon the Coorong beach. That omission was responsible for a great deal of the speculation respecting the probable inundation of Central Australia. The simple unadorned story of the methods by which the inland sea theory was exploded and the actual condition of the interior revealed forms one of the most romantic and inspiring chapters of South Australian history.

The honor of having made the first important discovery in South Australia is due to Lieutenant Grant, who, on December 3rd, 1800, sighted Mount Gambier from the deck of the *Lady Nelson*—colloquially known as “His Majesty’s Tinder Box.” The vessel was sailing along the coast towards Bass Straight on her voyage from England to Sydney. Grant did not examine the shore of the Australian Bight, and he returned to England before Flinders made his systematic survey. When Governor King saw Grant’s chart after the *Lady Nelson* reached New South Wales, he made a note on the margin to the effect that he thought the appearance of the coast warranted the belief that the entrance to an inland sea would be found in the Bight. Grant can scarcely be regarded as one of the explorers of South Australia. The pioneer in that work was Captain Matthew Flinders, the intrepid young naval officer who discovered and named the two gulfs, the principal capes, headlands, bays, islands, and other prominent landmarks from Cape Nuyt to Encounter Bay. Flinders possessed considerable literary skill, and he wrote a remarkably accurate series of pen pictures of the hitherto unknown coast of Southern Australia, which suggested the desirableness of founding a British province on the southern coast of “New Holland.” The meeting of Flinders and Captain Baudin, commander of the French exploring ship *Le Geographe*, in Encounter Bay, was a romantic incident which marked the completion of the British officer’s original work on the south coast. Flinders was accompanied by Sir John Franklin, the celebrated Arctic explorer, who joined the *Investigator* as a midshipman. The monument which Franklin, when Governor of Tasmania, erected at Port Lincoln to the memory of his old commander serves as a link to connect the first of the splendid band of Australian explorers with the brilliant navigator whose life was sacrificed in an attempt to perform similar work amid the eternal ice fields of Arctic seas.

Captain Sturt was the first explorer whose work on Australian soil was worthy to be compared with that which Flinders had accomplished on the water. His life and explorations have a special interest for South Australians. A considerable part of his colonial career was spent in this State, and the greatest task of his life was completed within its territory. Sturt was a man of dauntless courage, boundless energy, and shrewd common sense. He started on his first expedition on November 10th, 1828. After encountering many obstacles the party struck a large stream, but the water was so impregnated with salt that even the thirsty cattle refused to drink from it. After following the river for two days without finding fresh water, Sturt was compelled to return to the depot at Mount Harris. Before leaving the river he named it the Darling, after the Governor of New South Wales. The story which he had to tell on his return to the settlement only served to

stimulate interest in the problems which he had been endeavoring to solve, and in September, 1829, the Governor gave instructions for a second trip. Sturt on this occasion was accompanied by Mr. (afterwards Sir George) Macleay, and the party was provided with a complete equipment, including a whale boat. The Murrumbidgee was reached on September 25th, but as the expedition approached the meridian of longitude, at which most of the other unknown rivers exhausted themselves, the leader was concerned to find that there was not sufficient food to enable him to proceed farther with his teams. He thereupon resolved upon the bold expedient of continuing the journey in the boat. On November 6th the boat party left its companions behind and set out upon the eventful and arduous voyage. It was a bold enterprise, because every mile that the little craft floated down stream took the party farther away from its base. Nobody had any idea where the river would end. The active hostility of the natives proved a severe strain. Sturt's verdict respecting that portion of South Australian territory has been condemned as unwarrantably pessimistic, but it must be remembered that by the time he reached Lake Alexandrina he was physically worn out, and had no time to examine the land beyond the immediate vicinity of the stream. Passing through the Great Lake, Sturt and his little band were mortified beyond description when they discovered that so noble a river as the Murray had so miserable a termination. From the first the explorer recognised that the Murray mouth would prove a drawback to the river trade. A subsequent examination confirmed his first impressions, and Sturt's opinion that the Murray mouth was not safe for navigation has been confirmed by experience. Keenly disappointed at finding that the river emptied itself into the sea at a point exposed to the full force of the ocean, Sturt began the long and toilsome journey back to the depot. The men under his command were ill-fitted for the task of pulling against the current day after day, and they suffered terribly from fatigue. When they left the Murray mouth their provisions consisted of a small quantity of flour. Game was scarce, and the party was constantly harassed by the natives. Yet for a whole month the men toiled like galley slaves at the oars, loyally obeying their chief's commands. Sturt records in his journal how he frequently overheard a man say to his companions at night, "I must tell the captain to-morrow that I cannot pull any longer." When the morning came every man would be at his post. Not a murmur would escape their lips during the day. When the little party reached the place where the skiff had been launched for the downward journey the greatest disappointment of the voyage was experienced. They expected that stores would have been forwarded from Sydney to the depot there, but that had not been done. The next depot was 200 miles farther up the stream, and 17 days elapsed before the emaciated men could lay aside their

oars. One of the party became deranged when the boat was still 90 miles from its destination, and Sturt was compelled to form a camp. Two of the strongest men were sent on to endeavor to obtain help. A week went by, and then relief arrived. Every member of the party eventually returned to Sydney. Sturt's report to the Government of New South Wales created widespread interest, and the Governor instructed Captain Collett Barker, another officer in the 39th Foot, to examine the country in the vicinity of the lakes and the Murray mouth more systematically than his brother officer had been able to do. It was while Captain Barker was endeavoring to carry out his commission in April, 1831, that he lost his life near the mouth through the treachery of the natives. Captain Sturt paid a heavy penalty for the strain to which his physical powers were subjected during that memorable trip. In 1838 he returned to South Australia, and was appointed Surveyor-General, with a seat in the Executive and Legislative Councils. He subsequently became Commissioner of Crown Lands, Registrar of the Province, and Colonial Secretary. In 1844 Sturt conducted an expedition into the interior, but was compelled to camp at Rocky Glen for six months owing to the intense heat (the glass registering 130° in the shade) and absence of water. He then pushed on to within 150 miles of the centre of the continent, and later discovered Cooper's Creek. His constitution was completely shattered, and his sight failed. Sturt was knighted on his deathbed in 1869, but did not live to receive the title.

Edward John Eyre, whose sensational journey from Adelaide to King George's Sound in 1840-41 was attended by one of the most tragic episodes recorded in Australian history, was an explorer of the practical type, whose chief object was to endeavor to open up pastoral country in the interior. He was a daring and intrepid bushman, and the story of his adventures in this State and Western Australia is full of interest. Eyre, who died in 1902, was a native of Lincolnshire, the county in which Captain Flinders, Sir Joseph Banks, and Sir John Franklin were born. About two years after he settled in South Australia the question of opening a stock route to Western Australia was mooted, and it was suggested that Eyre was the man to undertake so formidable a task. At a meeting held in Adelaide in 1840 he told the settlers interested in the project that he did not believe any track along the Australian Bight would prove practicable, but expressed his willingness to search for good pastoral country beyond Lake Torrens, which he had seen and named in the preceding year. The proposal was approved by the Government, and the fund raised by private subscription for the purpose of equipping a party was subsidised by a grant from the Treasury of £100. The expedition consisted of five white men and three natives, with 14 horses and 40 sheep. A stock of provisions was also dispatched to the head of Spencer Gulf in a small sailing boat. Eyre left Adelaide on June 18th, 1840, in company with

his friend Mr. E. B. Scott, Corporal Coles, John Baxter, and two native boys. They forced their way northwards for 400 miles until they reached the basin of Lake Torrens. Baffled and bitterly disappointed, Eyre was eventually forced to the conclusion that he could not proceed farther in that direction. "I had one of three courses to choose," he wrote, "either to give up the expedition altogether, to cross to the Murray to the east and follow up that river to the Darling, or, by crossing over to Streaky Bay to the westward to endeavor to find some opening leading towards the interior in that direction. After weighing all the advantages and disadvantages of each (and there were many objections to them all) I determined upon adopting the last." Eyre reached Streaky Bay and formed a depot there. Several weary months were spent in attempts to force a passage round the head of the Great Bight through country which Eyre characterised as "a hideous anomaly, a blot on the face of Nature, the sort of place one gets into in bad dreams." His third effort proved successful and some idea of the dogged determination which he displayed may be formed from the fact that he travelled 643 miles in order to reach a point 153 miles distant from his depot. Having arrived at the head of the Bight, Eyre formed the daring and desperate plan of sending the majority of his party back to Adelaide while he proceeded to King George's Sound with pack-horses, taking Baxter as his sole white companion. The horses were rested for several weeks, and, in spite of the fact that the Governor of the Province and Eyre's friends sent Mr. Scott back in order to urge him to relinquish the project, he refused to do so. Eyre and Baxter set out on their perilous journey from the head of the Bight on January 25th, 1841. The two white men and three natives took with them nine horses, a Timor pony, and several sheep. Seldom has such a hazardous undertaking been entered upon by a party so ill-equipped. Baxter lost his life before the goal was reached, and at one stage of the journey it appeared as though nothing could save the leader of the expedition from a similar fate. On one occasion the party was without water for four days, and on another it was reduced to such a desperate plight that Eyre was compelled to abandon everything that was not absolutely essential to life. Two of the natives deserted, but subsequently rejoined the party, murdered Baxter, and decamped, carrying most of the stores away with them. The condition in which Eyre found himself the next morning when day broke would have caused most men to despair. He was in a waterless desert 500 miles from the nearest settlement with an inadequate supply of provisions, and a black boy to assist him in guarding what remained from treacherous natives. Inactivity would mean disaster, and as soon as Eyre had buried the body of his devoted follower he resumed his journey. The boy remained loyal, and on June 2nd they reached Thistle Cove, where they found the French whaler *Mississippi*. The commander, Captain

Rossiter, treated Eyre with the greatest kindness. At the end of a fortnight Eyre determined to complete his self-imposed task. He reached King George's Sound without further mishap.

THROUGH THE HEART OF THE CONTINENT.

The immense belt of territory to which the term Central Australia is applied proved a hard nut for explorers to crack. The vastness of the country, the difficulties and dangers, served to fire the imagination of adventurous men. Many noble deeds were done far out of the sight of the public—with no thought of reward. It would be impossible to describe the amount of suffering endured by those who freely gave their lives to the work of solving the problems presented by inland Australia.

The first explorer who fell a victim to the hardships and dangers which beset the paths of the pioneer bushmen in Northern Australia was Ludwig Leichhardt, the Prussian scholar and scientist, whose fate has never been definitely ascertained. Leichhardt made his first trip into the interior from Brisbane to Port Essington in 1844-6. In October, 1847, he set out on his last journey with the object of travelling to the Barcoo River, and thence *via* the head of the Gulf of Carpentaria to Swan River. A letter was subsequently received by his friends which he wrote at Canning Down on February 26th, 1848. That was the last authentic news of the expedition, and, although it is supposed that the letter "L" which Gregory saw carved on a tree in lat. 24°25', long. 145°6', marked the sight of one of his camps, the theory has never been verified. Leichhardt was followed by the Hon. A. C. Gregory. After having made several journeys into the interior of Western Australia, he was commissioned in 1855, by the Royal Geographical Society of London, to search for the missing explorer, who had then been absent more than four years. The expedition was also fitted out for exploration purposes, and the late Dr. von Mueller accompanied the party as botanist. The explorers were conveyed to the mouth of the Victoria River by sea, and Gregory succeeded in following that stream to the east of the Fitzroy Range before the end of the year. Portion of the party eventually travelled to Mount Wilson, after which they retraced their steps and crossed the watershed of the Victoria River, and thence *via* the Roper River to the mouth of the Albert. Finding that the vessel which was to have met him there had not arrived, Gregory continued his journey overland to Brisbane. That trip has been described by a competent authority as "one of the finest, most extensive, and expeditious explorations which has ever been recorded in Australia." In 1858 Gregory made another unsuccessful search for Leichhardt. It was during this trip that he found the tree marked by the ill-fated explorer.

About the time that Gregory completed his last journey into the interior, the idea of crossing the continent from south to north began to exercise a

fascinating influence upon the minds of those who were interested in Australian geographical problems. The desire to achieve that object was stimulated by an offer from the South Australian Government of a bonus of £2,000 to the explorer who first succeeded in accomplishing the feat. John McDouall Stuart, representing South Australia, and Robert O'Hara Burke, the ill-fated leader of a Victorian expedition, started for the prize. Stuart was the first on the scene, and he had pushed his way to a point within 250 miles of the Gulf of Carpentaria before Burke's party crossed the continent. He was compelled to give up the attempt, however, and before he could fit out another expedition and return to the Northern Territory, Messrs. Burke and Wills had succeeded in passing his nearest approach to the goal. Those two courageous men were not destined to share the honor which Stuart enjoyed a few months later, of standing upon the northern shore of the continent. Burke and Wills proceeded down the Flinders River until they reached a point where the stream was affected by the rise and fall of the tide. They were provided with camels imported from India for the purpose, whilst Stuart accomplished his journey on horseback. Burke had left the bulk of his stores under the care of four men at Cooper's Creek, and but for the fact that the custodians of the goods—acting in accordance with their leader's instructions—left the depot on the very day that the travel-worn and starving advance party returned to Cooper's Creek, the gallant fellows might have been spared to enjoy the reward of their enterprise. They had endured terrible hardships during the return trip. One of the party died of starvation and fatigue. When the three famishing survivors reached the camp they found it deserted and only a small quantity of food available. Knowing that the remainder of the party could not be far in advance, Wills urged his leader to follow in their tracks, but Burke determined to strike across country towards the nearest sheep station, which proved to be much farther away than he expected. The three men were eventually compelled to return to Cooper's Creek, where Burke and Wills died from starvation. Their companion, King, managed to obtain a subsistence from friendly natives until he was rescued by a relief expedition. The bodies of Burke and Wills were eventually taken to Melbourne, where they were accorded a public funeral on January 21st, 1863. It is a pathetic fact that their bodies were brought to Adelaide at the same time that Stuart returned from his successful journey from the Southern to the Indian Ocean. This accentuated the joy with which Stuart was welcomed.

FROM OCEAN TO OCEAN.

Forty-one years have elapsed since John McDouall Stuart waded into the sea on the shore of Van Diemen Gulf and bathed his hands and face in the cool waters of the Indian Ocean after having crossed the continent from south to

north. It was the first time that such a feat had been accomplished, and it is not difficult to imagine the delight with which the tired and travel-stained little band gazed upon the ever-changing sea and listened to the music of its waves after their long and arduous ride through the heart of a great continent. The narrative of that great achievement which Stuart gave to the world after he reached Adelaide is one of the most thrilling stories of adventure ever penned. The heroic fortitude which he displayed during the return journey, when he was too weak and ill to sit in the saddle, has seldom been surpassed. On October 31st, 1862, he wrote in his journal—"I feel a little improvement this morning, which I hope will continue ; and I think I have reached the turn of this terrible disease (scurvy). On Tuesday night (this extract was written on Friday) I certainly was in the grasp of death. A cold, clammy perspiration, with a tremulous motion, kept creeping slowly over my body during the night, and everything near me had the smell of decaying mortality in the last stage of decomposition and of the grave. I sincerely thank the Almighty Giver of all Good that He, in His infinite goodness and mercy, gave me strength and courage to overcome the grim and hoary-headed king of terrors, and has kindly permitted me yet to live a little longer in this world. . . . What a sad difference there is from what I was when the party left North Adelaide ! My right hand nearly useless to me by accident, total blindness after sunset—although the moon shines bright to others, to me it is total darkness—and nearly blind during the day ; my limbs so weak and painful that I am obliged to be carried about ; my body reduced to that of infantine weakness—a sad, sad wreck of former days." In spite of bodily infirmity he continued to press forward.

The entry made in his diary on the following day reads—"Although in such a weak state, I shall try if I can ride in the stretcher (carried between two horses) as far as Hamilton Springs. Started early ; found the stretcher to answer very well. On arriving at the springs saw that there was not sufficient water for the horses, and, as I had stood this part of the journey so well, made up my mind to cross the range to Brinkley Bluff. Arrived there about 5 p.m. I have stood the long journey better than I expected, but feel very tired and worn out." On another occasion he wrote—"Started in the cool of the morning, and in two hours reached where the party were camped so much exhausted and so completely done up that I could not speak a word, the power of speech has completely left me. . . . Gave orders that a horse was to be shot at sundown, as we are getting rather short of meat. I hope the change of beef tea made from fresh meat will give me some increase of strength, for I am now reduced to a perfect skeleton, a mere shadow. . . . Fresh meat to the party is now a great treat, but I am denied participating in that pleasure from the dreadful state in which my mouth still is. I can

chew nothing, and all that I have been living on is a little beef tea and a little flour, which I am obliged to swallow." These extracts are typical of the entries in the explorer's diary for a period of three months, and they indicate the terrible suffering which Stuart and his brave men faced for many weary weeks. "Should anything happen to me I keep everything ready for the worst. My plan is finished and my journal brought up every night, so that no doubt whatever can be thrown upon what I have done. All the difficult country is now passed, and what remains is well known to those who have been out with me before ; so that there is no danger of the party not finding their way back should I be taken away." At the time Stuart penned these words, 18 years had passed since he gained his first experience as an explorer under the leadership of Captain Sturt. It was on Thursday, July 24th, 1862, that Stuart made the following entry in his journal :—" Thring Creek, entering the marsh. . . . At eight miles and a half came upon a broad valley of black alluvial soil covered with long grass ; from this I can hear the wash of the sea. . . . Crossed the valley and entered the scrub, which was a complete network of vines. Stopped the horses to clear a way, whilst I advanced a few yards on to the beach, and was gratified and delighted to behold the water of the Indian Ocean in Van Diemen Gulf before the party with the horses knew anything of its proximity. Thring, who rode in advance of me, called out 'The sea !' which took us all by surprise. Then they gave three long and hearty cheers. . . . I dipped my feet and washed my face and hands in the sea, as I promised the late Governor, Sir Richard MacDonnell, I would do if I reached it." The names of those who accompanied Stuart on that historic journey were Messrs. William Kekwick (second officer), F. W. Thring (third officer), W. P. Auld (assistant), Stephen King, John Billiatt, James Frew, Heath Nash, and John McGorrerey (shoeing smith). Mr. J. W. Waterhouse was also attached to the expedition as naturalist. The return journey was begun on Saturday, July 26th, from Charles Creek, near Chambers Bay, and the expedition reached Adelaide safely after an absence of 12 months and 13 days. Stuart was still suffering from the effects of the terrible attack of scurvy which had prostrated him in the interior, but the cordial welcome which he received from his fellow-colonists rewarded him in some degree for the hardships he had endured. Subsequently the South Australian Government gave him a more tangible expression of its appreciation. A resolution was carried in Parliament to the effect that £3,500 should be paid as a reward to John McDouall Stuart and the members of his party, of which sum the leader was to receive £2,000. The Royal Geographical Society of London awarded him its medal and a gold watch. His success as an explorer was phenomenal, and his five expeditions into the interior were carried out without the loss of human life. Stuart's journey

across the continent enabled him to give valuable advice regarding the proposal to construct a telegraph line across the continent to Port Darwin, and the line closely followed his tracks. Stuart died in England in 1869.

A GALLANT BAND.

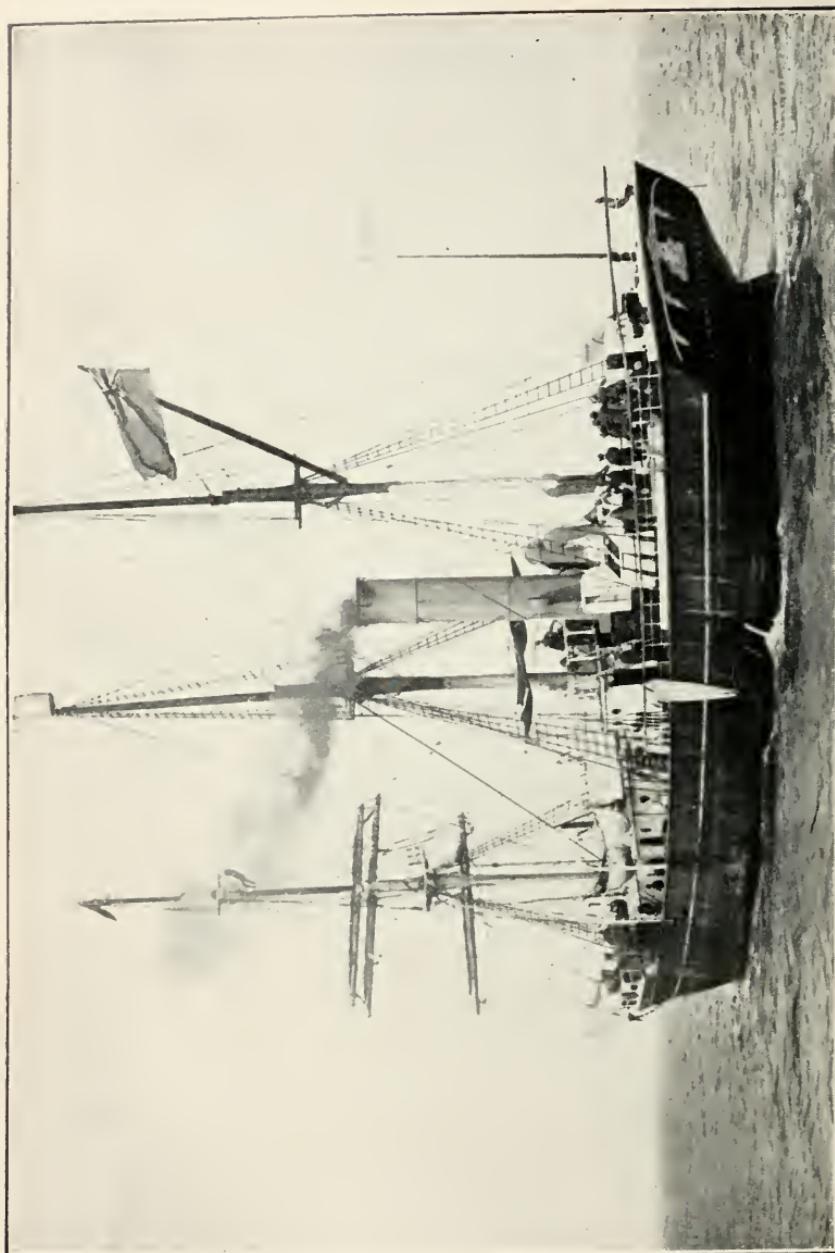
Since 1862 numerous explorers have been engaged in the task of determining the nature of the country on either side of the long but comparatively narrow strip of territory with which Stuart became familiar. The most important expeditions which have been equipped in South Australia during the last 40 years are worthy of reference, however, and a foremost place must be accorded to Ernest Giles, who acted as leader of several exploring parties. In 1872 Giles crossed fine country to the westward of the overland telegraph line, and soon after his return was appointed to command a party which mapped out about 700 miles of territory. In 1875 he was selected to command the expedition equipped by the late Sir Thomas Elder, and forced his way across hills and plains for 1,500 miles. During one stage of the journey no water was obtainable for 19 days, and even the camels suffered considerably. Giles was away for six months on that occasion, and travelled altogether about 2,400 miles. William Christie Gosse, who was for some time Surveyor-General of South Australia, entered the Government service in 1859, and was engaged in making trigonometrical surveys in the Far North. In 1873 he was sent out to explore new country about 800 miles south of Central Mount Stuart, with the ultimate object of pushing over to Western Australia. Gosse left Alice Springs in April, and discovered Ayers' Rock, which he named after the late Sir Henry Ayers. He failed to reach Western Australia, and returned to Alice Springs in December, 1873. He was successful, however, in obtaining an accurate geographical knowledge of 60,000 square miles of new country. Gosse died in 1881, before he was 40 years of age. Major Peter Egerton Warburton, formerly Commissioner of Police in Adelaide, conducted several expeditions into the interior between 1856 and 1874. In 1873 he started across the continent, and with the aid of camels he succeeded in reaching an out-station in Western Australia after nine months travel. During the latter part of the time the party subsisted mainly on the flesh of worn-out camels. He was rewarded for his enterprise by a grant of £1,000 from the South Australian Parliament, and was created a C.M.G. in 1875. He died in 1889.

Mr. David Lindsay, F.R.G.S. was selected in 1883 to lead an expedition which was about to proceed to Arnheim Land; and afterwards conducted another party through the interior. On the latter occasion he explored the country between the overland telegraph line and the Queensland border. He discovered a deposit of rubies in the MacDonnell Ranges, which at the time

excited great interest ; and a few years later was chosen as the leader of the Elder Exploring Expedition, which was equipped for the purpose of scientifically examining the unmapped portions of Australia. Mr. Lindsay passed within 12 miles of the Coolgardie goldfields, and was the first to call attention to the existence of the large auriferous region in the western State. Mr. L. A. Wells' explorations, Mr. Davidson's work in Central Australia during the years 1898 and 1901, the splendid labors of the late Mr. Winnecke, Mr. R. T. Maurice's late expedition through a large tract of country to the north of Fowler's Bay, are contemporary history, the details of which are familiar to all South Australians who take an interest in the development of the State and its northern dependency.

Not a year goes by—scarcely a day—without an addition to the map of some range of hills, lakes, a tract of country suitable for the raising of live stock, or an auriferous belt where the prospector may with advantage follow up the success of the road-breaking legion. The roll call of South Australian explorers contains many honored names of men who nobly did their duty in making known the interior of the continent and letting light into “Darkest Australia.” They were the pathfinders and bridgebuilders—the “road-breakers” who made possible the peaceful occupation of the country for industrial development.

[The return during February, 1914, of Dr. Douglas Mawson and his companions from their Antarctic explorations is of special interest to South Australia. Dr. Mawson's connection with the Adelaide University, the presence of several South Australians in his party, and the return of the *Aurora* to Port Adelaide, enabled the citizens of this State to tender the first public welcome to these explorers whose enforced stay in Antarctic regions has added to the public interest in the valuable work of this expedition, which was particularly Australian in character.]



Return of the "Aurora" to South Australia with Dr. Mawson and his Party.

[Krischek, Photo.]

SUMMARY OF FACTS ABOUT SOUTH AUSTRALIA.

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SOUTH Australia was proclaimed a "Province" under the British Crown on December 28th, 1836.

It is the "central" State of the Commonwealth, its eastern boundary being the border line of the States of Victoria and New South Wales, and also touching Queensland, while a portion of Western Australia forms its western boundary.

Before the Northern Territory was transferred to the Commonwealth South Australia controlled the great extent of territory from the southern to the Indian Ocean lying between the three eastern States and Western Australia.

AREA.—380,070 square miles.

LAND.—Leased for pastoral purposes, 96,356,850 acres; alienated from the Crown, 10,252,746 acres; area under cultivation (1912-13), 4,631,164 acres.

POPULATION.—South Australia (31/12/13), 440,047; Adelaide and suburbs (31/12/13), 200,917; death rate, 10.28; birth rate, 28.65; marriage rate, 9.62 per 1,000 of population.

PUBLIC EDUCATION (1912).—Number of public schools, 768; number of scholars, 58,273.

PUBLIC FINANCE (1912-13).—Revenue, £4,506,698; expenditure, £4,330,282; surplus, £176,416.

SURPLUS REVENUE.—(Set aside for redemption of public debt)—Five years (1908-9 to 1912-13), total £1,433,154.

RAILWAYS (1912-13).—Miles open, 1,689³/₄; cost of construction (on average miles open), £14,178,485; gross revenue, £2,222,436; net revenue, £828,661, or 5.84 per cent. on average capital cost.

BANKING (June 30th, 1913).—Deposits at Savings Bank, £8,608,479; banks of issue, £11,522,755; total, £20,131,234. The Savings Bank has 204,565 depositors with deposits averaging £42 1s. 7d. each.

TRADE AND COMMERCE OVERSEA (1913).—Imports, £7,345,123; exports, £9,809,763; total oversea trade, £17,154,886.

PRINCIPAL ARTICLES EXPORTED OVERSEA DIRECT (1912).—*Breadstuffs*, £3,245,109; *pastoral products*, £2,685,321 (wool, £2,032,383; skins and hides,

£432,052; meat, tallow, and lard, £197,601; other, £23,285); *fruits*—dried, fresh, &c., £80,899; *wine*, £53,763; *bullion and specie*, £586,070; *concentrates and ores*, £2,297,252; *copper*, £369,400.

SHIPPING (Inwards, 1912).—Ships, 1,213; tonnage, 3,662,060.

LIVE STOCK (1912).—Cattle, 383,418; horses, 276,539; sheep, 5,481,489; pigs, 69,832.

CULTIVATION.—Cereals, fruits, &c. (1912-13)—Area under cultivation, 4,631,164 acres. Production—wheat, 21,496,216bush.; average 10·34bush. per acre. Average wheat yield for last five seasons, 22,145,040bush., or 11·18bush. per acre. Wine made (1913), 3,974,838galls.; currants, 52,208ewts.; raisins, 35,248ewts.

DAIRYING (1912).—Number of dairy cows, 114,734 (in milk, 79,325); butter made, 8,391,557lbs.; cheese made, 1,958,027lbs.; bacon and hams cured, 3,771,064lbs.

MANUFACTORIES (1912).—Number of factories, 1,341; hands employed, 28,500; salaries and wages paid, £2,869,965; gross value of output, £13,438,218; value of land, buildings, plant, and machinery, £5,878,374.

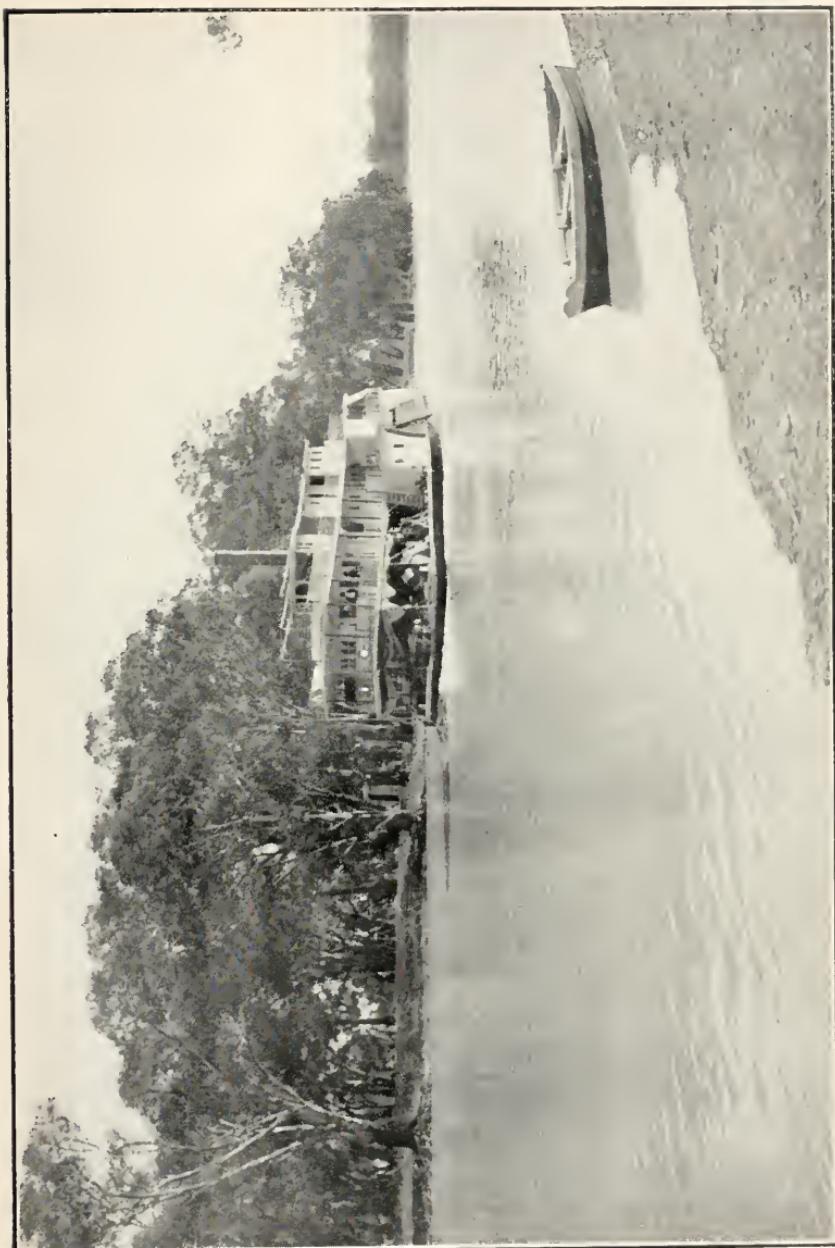
VALUE OF PRODUCTION (1912-13).—*Crops*—Total value, £7,908,285 (cereals, hay, &c., £6,587,359; orchards, vineyards, and gardens, £1,308,726; miscellaneous, £12,200). *Mineral*, £585,478; *Manufactories*, £5,239,108; *poultry and eggs*, £541,489.

THE CLIMATE.—South Australia's climate is unsurpassed in the civilised world. The southern agricultural districts are highly reminiscent of that of Italy and Spain. In the summer there are occasional severe bursts of heat, but it is wonderfully dry and health-promoting. Humidity in the atmosphere is almost unknown.

WEALTH IN GRAIN.—The wheat crop has averaged 22,145,040bush. a season for the last five years, or a mean annual value of £5,570,719. South Australian wheat is specially esteemed by millers, because of its hardness and gluten contents.

AGRICULTURAL EXPANSION.—In 1912-13 there were 2,579,560 acres sown to wheat and 1,537,789 acres under fallow. Of the area at present occupied it is estimated that 12,439,000 acres are suitable for wheat-growing. Active steps are being taken to make available to the farmer another 5,000,000 acres in assured rainfall districts. The surveying of these vast areas is going hand in hand with railway construction, water conservation, and other aids to new settlement.

LIBERAL LAND LAWS.—The terms for the acquisition of land are purposely designed to relieve the settler during the pioneering work of the first few years.



View showing Timbered Flats, River Murray.

[R. W. Martin, Photo.]

Blocks may be taken up on perpetual lease or agreement to purchase, the latter extending over 36 years, with no interest to pay for the first four years, 2 per cent. in the fifth and sixth years, and 4 per cent. thereafter.

SOUTH AUSTRALIANS FARM THEIR OWN LAND.—Out of 9,299,586 acres of privately owned land, all but 977,634 acres is occupied by the owners.

MIXED FARMING.—The conditions are ideal for mixed farming, and the great majority of the agriculturists combine wheat-growing with dairying, lamb-raising for export, and poultry pursuit. In a recent competition six White Leghorns laid 1,589 eggs in 12 months, or an average of 265 per hen. The sheep flocks number 5,481,489 head, which last year produced 53,387,053 lbs. of wool.

GOVERNMENT AIDS.—The Government has provided for the farmer the finest produce export dépôt of its kind in the Southern Hemisphere, experimental wheat and stud stock farms, a Government Butter Factory, and experts lecturing free all over the country.

THE ORCHARD STATE.—South Australia is the largest exporter of wine and brandy in the Commonwealth, and although nearly 4,000,000 gallons. is produced annually, the supply is not equal to the demand. Grapes are often sold in the shops at 1d. a pound. There are orchards in which all the following varieties of fruit trees flourish :—Apples, apricots, almonds, figs, peaches, pears, plums, quinces, cherries, oranges, lemons, loquats, and walnuts.

THE VALLEY OF THE MURRAY.—One of the greatest national undertakings ahead of New South Wales, Victoria, and South Australia is the locking of the River Murray in the interests of irrigation and navigation. Last year Renmark, in South Australia, produced £135,000 worth of fresh and dried fruits from 5,237 acres of irrigable land, and at many other settlements along the river there is a healthy boom in irrigation, the potentialities of which are enormous.

SECONDARY PRODUCTION.—Although South Australia is a truly rural State, it has another big side to its national prosperity. It possesses the largest silver-lead smelting works, furniture factory, winery, and tin and ironware factory in the Commonwealth. Its 1,341 factories employ 28,500 people, drawing £2,869,965 annually in wages, and producing goods worth £13,438,218.

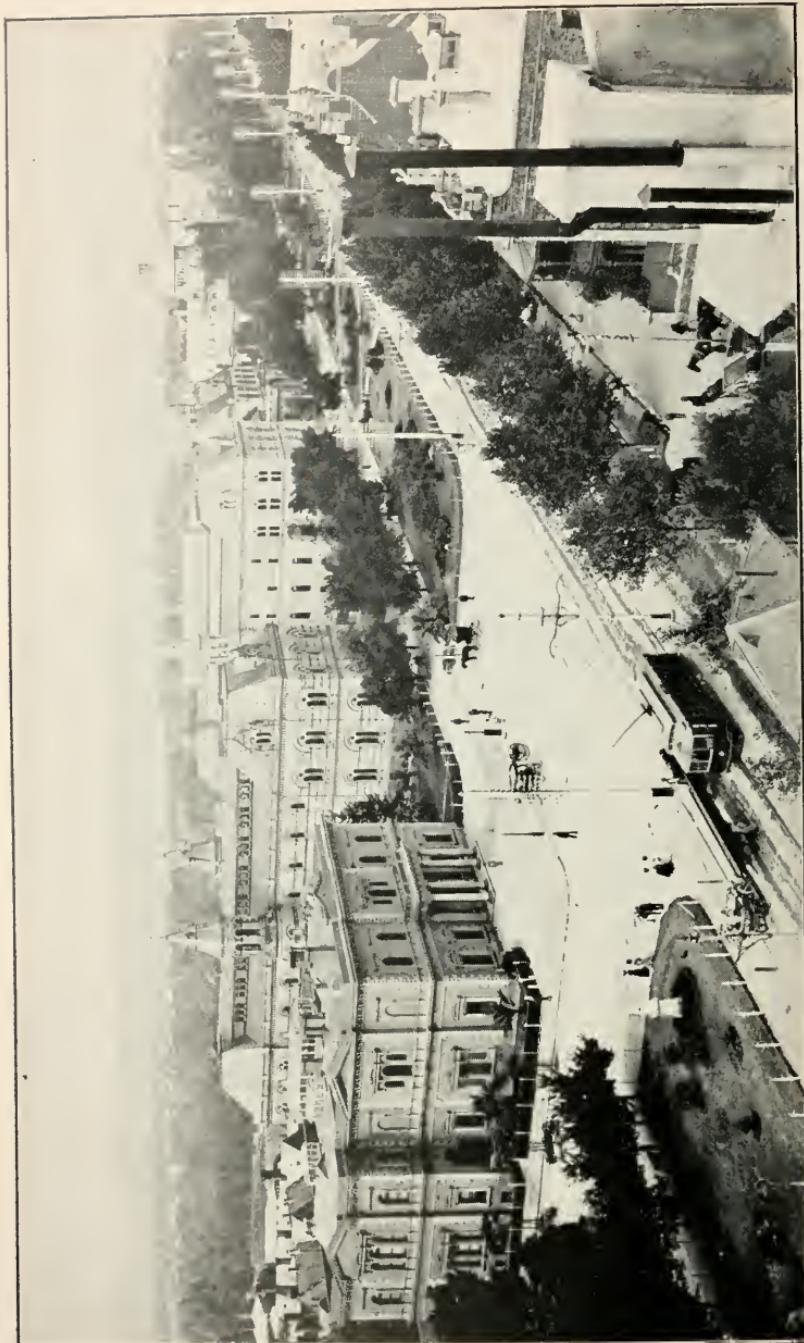
THE RAILWAYS.—South Australia constructed the first State-owned railway in the British Empire, and now the people own 1,600 miles of lines, which are returning 5·84 per cent. above working expenses. Upon railway extension in new districts the expenditure of another £2,000,000 has been authorised.

CONDITIONS OF LABOR.—The average wage of male and female factory hands is £105 12s. 8d. per year. The minimum pay for general laborers is 8s. per day. The Government gives liberal advances for the erection of workers' homes. The eight hours system and the Saturday half-holiday are almost universal. The wages board principle and workmen's compensation for accidents are operating in a beneficent and smooth way.

THE BEAUTIFUL CAPITAL.—These comments are culled from the Visitors' Book in the Tourist Bureau at Adelaide:—"Adelaide is the best and most beautiful city I have ever seen." (An English traveller). "Sorry I am going farther. A lovely city." (A resident of the Isle of Man). "The Queen city of the States." (A Melbourne man's opinion). "A pattern city for Australia." (The tribute of a New South Welshman). "Of all cities I have seen, Adelaide comes easily first in the perfect beauty of its situation and arrangement." (Frank T. Bullen in his book, "Advance Australasia.")



View in Wilpena Pound, Flinders Ranges.



North Terrace, Adelaide, showing Institute, Public Library, and University Buildings.

SOUTH AUSTRALIA FOR TOURISTS.

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IT is but fitting that South Australia, as one of the younger daughters of the Empire, should also merit the distinction of being one of the fairest of the countries glorying in allegiance to the British Crown. Though the State cannot boast of many mighty rivers, awe-inspiring waterfalls, or stupendous chasms, it is replete with examples of the handiwork of Nature when in its most pleasant and happy moods. From Cape Northumberland in the south to Wilpena Pound in the north there are features that compel the attention and admiration of the lover of the beautiful in land and sea scape, while over and above all is the bracing climate, which for health and enjoyment is unexcelled anywhere in the world.

Situated on a fertile plain, midway between the sea coast and the Mount Lofty Ranges, Adelaide, the capital, will forever stand as a tribute to the ability and foresight of its designer, Colonel Light. With its encircling belt of park lands and public gardens, aggregating in area 2,000 acres, wide thoroughfares, and avenues of trees, it well deserves its title—"The Garden City." Adelaide is an up-to-date city, furnished with modern conveniences. An electric tramway system, which is owned and controlled by the municipalities interested, serves the surrounding suburbs, and its well-designed Botanic and Zoological Gardens and fine public and private buildings afford further evidence of the enterprise of its citizens. A centre of interest is what is termed "Educational Square" on North Terrace, east of King William Street, comprising the Institute and Reading Room; the Public Library, Museum, and Art Gallery; the University and Elder Conservatorium of Music; the Exhibition Building; and the School of Mines and Industries. "Adelaide," said Viscount Bryce, ex-British Ambassador at Washington, on the occasion of his visit in 1912, "thoroughly deserves all, and more than all, that travellers have said of its beauties and charms. It stands upon a rich, fertile plain, like my own beloved Oxford, and reminds me much of that place. Oxford, however, does not possess the lovely mountain range holding in its recesses such a beautiful variety of entrancing scenery. What a pleasure it must be to have those hills so close at hand and to be able to commune with Nature in her inmost secrets. What delight it must be to be able to view from the summit those exquisite lights and colors stretching down to the blue expanse of ocean in the distance. Adelaide people are, indeed, fortunate in the situation of their city."

MOUNT LOFTY RANGES.

The advantages arising from the near situation of the Mount Lofty Ranges to the city are almost inestimable. Hidden in their recesses are flourishing orchards and gardens, fairy dells, where maidenhair and other ferns luxuriate ; everywhere the exhilarating atmosphere is filled with the delicious scent of sweet briar or other flowers, and here and there charming townships invite the tourist to stay awhile and revel in the beauties of Nature and enjoy at the same time all the conveniences of modern civilisation. The view of Adelaide and its environments which may be obtained from any of the vantage points in the ranges has been characterised as the best of its kind to be obtained in the British Empire. Mount Lofty, the highest peak, is by road about 12 miles from the city. From this eminence, 2,334ft. above sea-level, a magnificent panorama is afforded, it being possible on a clear day to see 60 miles in nearly every direction. Of historic interest is an obelisk erected on the reserve in honor of Captain Matthew Flinders, commander of the ship *Investigator*, who, from Kangaroo Island, on March 23rd, 1802, discovered and named Mount Lofty.



View from Mount Lofty Summit. Gardens in a Valley of the Ranges.

Recognising the value to the community of open spaces amid beautiful surroundings, the Government have reserved areas at various places in the ranges as public pleasure resorts. The most extensive of these is the National

Park, comprising 2,000 acres, situated at Belair, about 14 miles on the inter-State railway line from Adelaide. Nearer the city, almost at the foot of the ranges, are the Waterfall Gully and Morialta Falls reserves. At all of these reserves facilities for the enjoyment and convenience of visitors have been provided, while care has been taken to preserve the native flora and vegetation.



Roadside Scene, Hindmarsh Valley.

THE SOUTH COAST.

Situated on the southern coast, and connected by rail with the metropolis, Port Elliot and Victor Harbor are deservedly the most popular watering places in the State. During the summer both these resorts are crowded with visitors. Portion of the coast is fringed with huge granite cliffs, and the unceasing roar of the mighty breakers of the Southern Ocean as they dash with impotent fury against the rocks is a never failing attraction. Here and there among the rocks charming bays with clean white sand provide sheltered nooks for picnic parties and safe bathing, while conveniences for boating and fishing are at all times available. Granite Island, which lies a short distance from Victor Harbor and is connected with the mainland by a causeway, abounds in pleasant walks and boulder-shaded retreats. In the vicinity of Port Elliot and Victor Harbor are a number of attractive places. These include Middleton, with its charms for the conchologist; the Murray Mouth,

reached by driving along a fine stretch of beach; Hindmarsh and Inman Valleys, with their gardens and waterfalls; Hindmarsh River; and the Bluff (Rosetta Head), at the western extremity of Victor Harbor. From the summit of the Bluff, near by which a whaling station existed in the early days, a splendid view of the coast reaching to the Murray Mouth and seawards almost to Kangaroo Island may be obtained.

THE SOUTH-EAST.

The South-Eastern district is of special interest to the tourist. In this well favored portion of South Australia is Mount Gambier, with its wondrous crater lakes, many curious caves, and typical English scenery. The town is most pleasantly situated, and a drive along any of the good roads for which the whole district is famed is of more than passing interest. The Glenelg River, a beautiful stream 26 miles from Mount Gambier, is much favored by sportsmen, whether with gun or rod. In the South-East also are the world-famed Naracoorte Caves, with their marvellous treasure of stalactites and stalagnites, which for beauty of form, variety of color, and transparency can hardly be excelled. Commenting on these caves the Rev. Julian Woods, F.G.S., said—"In point of magnitude and splendour, and in a scientific view they do not yield in importance to the Adelsberg Caves, the caves in the Peak of Derbyshire, the Guacharo Caves, and those in New South Wales and Tasmania." Other noted holiday and health resorts in this pleasant district are the attractive watering-places, Port MacDonnell, Beachport, and Robe, and of special interest is Dingley Dell, at one time the home of Adam Lindsay Gordon, the talented poet, whose romantic career is well known to the majority of Australians.

THE RIVER MURRAY.

The River Murray—Australia's greatest waterway—flows through South Australian territory for nearly 400 miles. Of the many opportunities for enjoyment available in the Commonwealth few can vie with those afforded by a trip on one of the well appointed pleasure steamers which traverse its peaceful waters. Whether it be the world-wide traveller seeking acquaintance with sights and scenes unique to Australia, the seeker after lazy enjoyment under the most healthful of conditions, the inquirer for information respecting scientific irrigation and fruit-growing, or the sportsman eager to prove his prowess, a trip up stream on the Murray should satisfy all requirements. A few miles from the Murray Mouth, Goolwa, one of the oldest towns in South Australia, and where some of the most interesting events connected with the early days of the State happened, commands the traveller's attention. It was near Goolwa that, as far back as 1830, Captain Sturt and Sir George



Type of Steamer Trading on the River Murray.

[R. W. Martin, Photo.]

MacLeay, the first white men to navigate the full length of the Murrumbidgee and the Murray from its junction with that stream, landed, and it was there also, that Captain Barker, some 12 months later, met his death at the hands of the natives. To-day Goolwa, owing to its many advantages for boating, fishing, and shooting, is a popular holiday centre. The journey from Murray Bridge to Renmark, South Australia's largest irrigation settlement, is of unfailing interest. As the bends of the river are rounded fresh prospects are presented, and the flourishing irrigation settlements which are passed *en route* furnish a striking tribute to the fertile nature of the soil when scientifically irrigated.

NORTH OF ADELAIDE.

North of Adelaide are many thriving districts, each of which has its particular attractions for the tourist. Gawler, 25 miles by rail from the metropolis, is most pleasantly situated, and on the journey a glimpse of the State railway workshops and the city abattoirs is obtained. Seven miles from Gawler, at Roseworthy, is the Government Agricultural College, the first institution of its kind in the Commonwealth and an important factor in bringing the practice of agriculture in South Australia to its present high standard. Angaston, 26 miles by rail from Gawler, and Clare, which from the railway can be reached by a pleasant drive, the visitor having the choice of three routes, are both centres of districts famous for orchards and vineyards.

Port Pirie, the chief outport of South Australia, is a busy shipping centre, the silver-lead smelting works of the Broken Hill Proprietary Company located there being the most extensive and complete in the world. Port Augusta, at the head of Spencer's Gulf, near by which is an ostrich farm, as the junction of the transcontinental railway line to Kalgoorlie now under construction and the proposed line to Port Darwin, is destined to have an important future.

PORT LINCOLN.

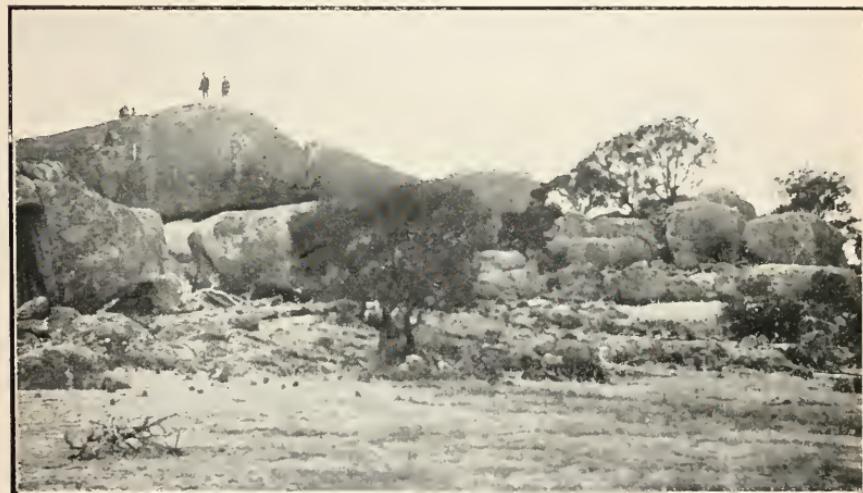
Port Lincoln, the chief port of Eyre's Peninsula, was discovered and named by Captain Matthew Flinders in the course of his historic voyage on H.M.S. *Investigator* in 1802. For many years a popular holiday resort, the town, owing to the rapid settlement of the surrounding mallee country during the past decade, is now also an important commercial centre. It is served by lines of well appointed steamers, the trip from Port Adelaide occupying about 12 hours. On account of its magnificent harbor Port Lincoln has been selected as a sub-base for the Australian Royal Navy. Railways run inland from the port in several directions, and the task of transforming virgin mallee land into profitable wheat-growing areas is still proceeding apace. The native

flora, a few miles distant, is of great variety and beauty, and the abundant opportunities afforded for boating, bathing, fishing, and shooting add to the delights of a visit to the port.

KANGAROO ISLAND.

Kangaroo Island, about 70 miles distant by steamer from Port Adelaide, is, because of the salubrious nature of its climate, frequently termed "The Australian Isle of Wight." Even in the middle of summer the atmosphere on the island is almost invariably cool and refreshing, and this, combined with its many other attractions, has gained for it a high reputation as a sanatorium and holiday resort.

There are many other places in the State which, by reason of their natural beauty, deserve to be particularised did space permit. Included in the above, however, are those more easily accessible and which, mainly through the agency of the State Tourist Bureau, are becoming better known and appreciated, both by local residents and inter-State and oversea visitors.



Chandada Rocks—Eyre's Peninsula.

PHYSICAL FEATURES.

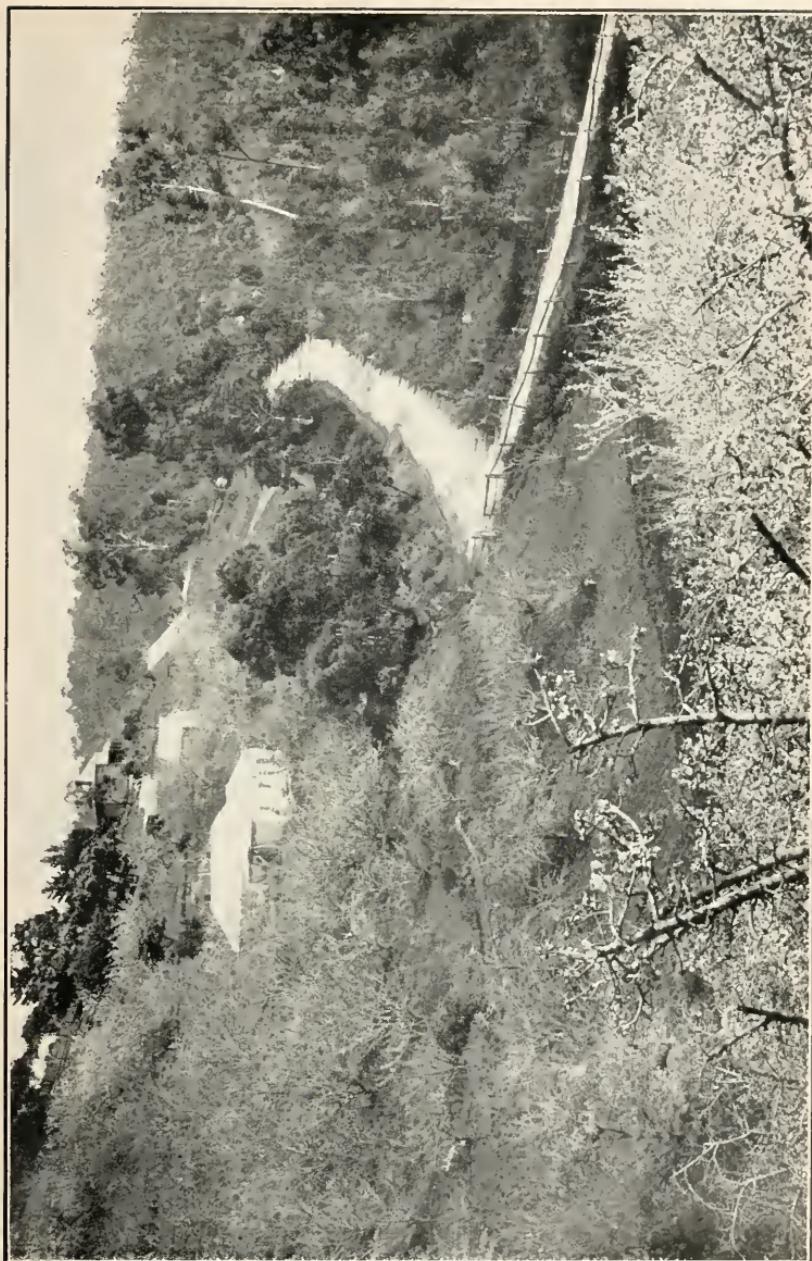
The River Murray, Australia's monarch waterway, takes its rise in the Australian Alps, near Mount Kosciusko, and with its tributaries—the Darling, the Murrumbidgee, and the Lachlan—is at certain seasons of the year navigable for a distance of 3,212 miles. The tract of country which forms the watershed of these rivers comprises 265,121,920 acres, or an area double that of France. For nearly 400 miles the Murray flows through the eastern portion of South Australia, and its fertilising waters have by irrigation been placed upon lands in the valley of the river in this State with splendid results. There remain many thousands of acres which can be economically irrigated from this great waterway, and thereby made capable of supporting a very large population. In addition, in the lower reaches of the Murray there are approximately 288,000 acres, more or less, subject to inundation, of which it is estimated 150,000 acres can be profitably reclaimed. Analyses and results following on the cultivation of areas previously reclaimed have proved these swamp lands to be some of the richest in Australia. A scheme of reclamation and irrigation is now being undertaken by the Government, and blocks are made available for settlement as the work progresses. The river is now navigable for 160 miles from its mouth at all times and throughout its whole length in South Australia for the greater portion of the year. The Governments of the States interested and the Commonwealth have, however, entered into an agreement, subject to the ratification by the respective Parliaments, for the locking of the river and the construction of storage basins. These works it is anticipated will ensure the permanent navigability of the Murray, and also provide ample water for irrigation purposes.

There are 26 other streams in the State, and their lengths aggregate 2,333 miles.

MOUNTAINS.

Twenty-two mountain ranges intersect the State, some attaining the altitude of nearly 4,000ft. During the winter months frost is a frequent visitant of these ranges, and snow occasionally falls on the heights. The annual rainfall in the hills districts varies from 20in. to 30in.

The first of these, the Mount Lofty Range extends from Cape Jervis to the River Light, and includes the Bluff, Bremer, Bull's Creek, Sellick's Hill, Mount Gould, Barossa, and the Murray Ranges, then continues under the names of Tothill's, Camel's Hump, Bald Hill Range, Brown's Hill Range, Never Never, and Campbell's Ranges to Ulooloo, then to hundred of Hardy, east of Petersburg, as the Porcupine Range. The highest points are Mount Lofty, 2,334ft.; Mount Barker, 1,681ft.; Kaiserstuhl, 1,973ft.; Mount Cone North, 2,601ft.; Razorback, 2,834ft.; Mount Bryan, 3,065ft. above sea level. Its length is about 230 miles, and it has an average width from 15 to 30 miles.



View near Marble Hill, Mount Lofty Ranges.

The Flinders Range begins a little north of the River Broughton in latitude 33° 18', passing from 10 to 15 miles east of Spencer's Gulf, and runs northerly to Mount Distance, where it ends, about 30 miles from Lake Blanche. The highest points are Mount Remarkable, 3,178ft.; Mount Brown, 3,200ft.; Mount Arden, 2,750ft.; Mount Serle, 3,060ft.; Mount Benbonyathe, 3,470ft.; Freeling Heights, 3,120ft.; Mount Aleck, 3,700ft.; the highest being St. Mary's Peak, at Wilpena Pound, 3,900ft. above sea level.

Subsidiary ranges are Ragless, Yappala, Elder's, Chace's, Druid. The proximity of the Bunker increases the width of Flinders Range in places to about 50 miles, whilst in narrower places it is only from about five to ten miles wide. It extends for a length of about 260 miles, in sections.

The Hummocks and Barunga Ranges begin at the head of St. Vincent's Gulf and extend northwards for about 50 miles to the River Broughton and do not generally exceed two miles in breadth. The highest point is Barn Hill, 1,169ft. above sea level.

The Musgrave Ranges, including the Everard, Tomkinson, Krichauff, Mann, Blych, and Birksgate Ranges, are situate immediately south of the 26th parallel of latitude, and extend from about 100 to 400 miles west of Oodnadatta, and are about 100 miles wide. The highest points are Mount Woodroffe, 3,786ft.; Mount Morris, 3,732ft. above sea level.

The Gawler Ranges are a line of hills to the south of Lake Gairdner, extending from the neighborhood of Port Augusta towards Streaky Bay. The highest points are Mounts Micolo, Double, and Fair View, Nukey Bluff, and Scrubby Peak, none of which exceeds 1,600ft. above sea level. The length of the range is about 200 miles, and breadth from 10 to 20 miles.

Baxter's Range and Middleback Range are small ranges extending southward from the Gawler Ranges, west of Port Augusta, along the west coast of Spencer's Gulf to near Franklin Harbor.

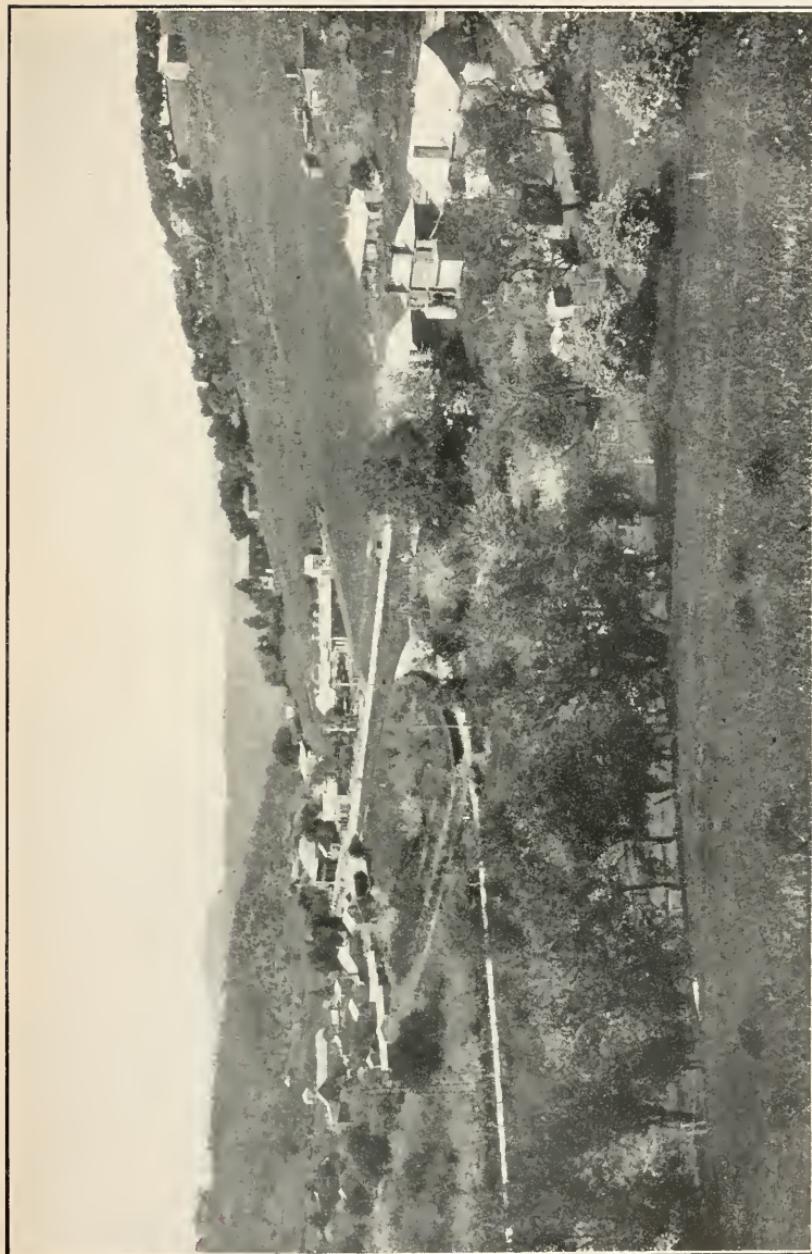
Waroonee and Pualco are detached ranges skirting the Eastern Plains, each about 20 miles long and two miles wide.

Willouran Range, situated south-west of Hergott Springs, is about 30 miles long, north and south, and extends about the same distance westward, the hills becoming disconnected and lower. The highest point is Termination Hill, 1,230ft. above sea level.

Denison Range, to west of Lake Eyre, runs northerly for about 70 miles, and has a width varying from 15 miles at the south end to about five miles at the north.

Stuart Range is situated to the north-west of Lake Torrens, and consists of low detached hills extending for about 60 miles in a north-westerly direction, and is of irregular width, varying from five to 20 miles.

There are a few ranges in the South-East, but none of these have sufficient elevation to be ranked as mountain ranges.



Clarendon, a Southern District Township.



Nymphaea Lilies, Botanic Garden, Adelaide.

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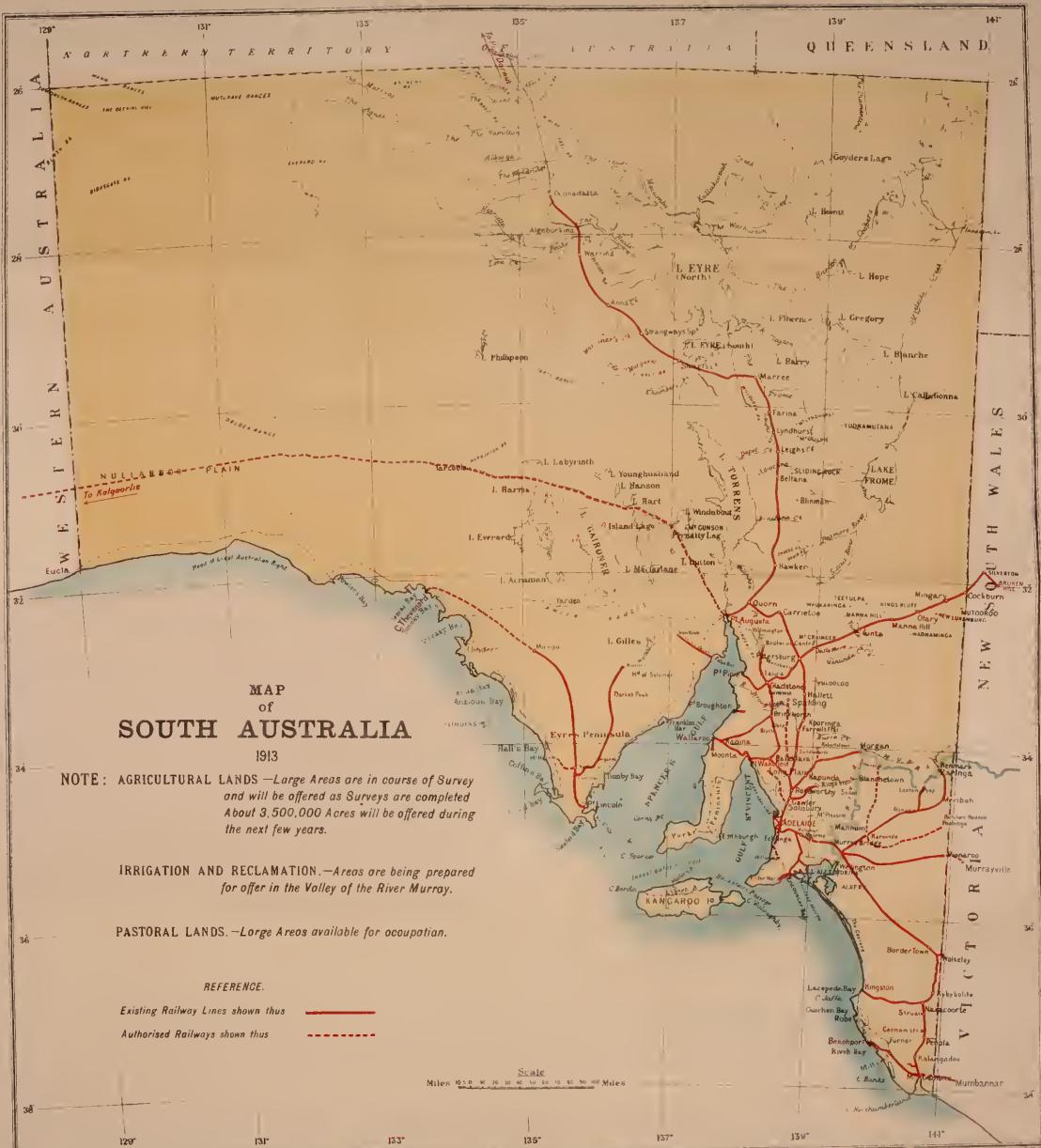
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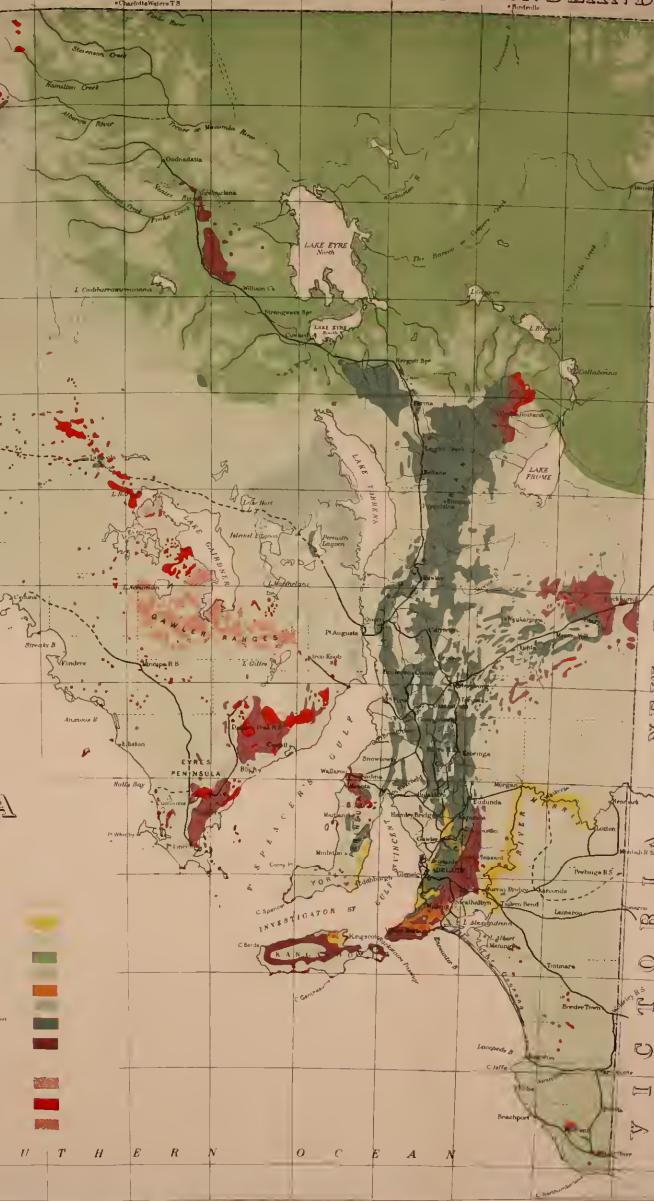
SOUTH AUSTRALIA

Based mainly on the geological maps of H. V. L. Brown.

LEGEND

W/2007A

RECENT TO PLIOCENE	Brave RRP of the last interglacial and early Holocene, most glacial areas still 1°-3° warmer than what atmospheric and oceanic circulation models predict. Glaciers still active.
MIOCENE AND EOCENE	Brave RRP, most regions get great insolation, very little biomass and short days. Subtropical, Intertropical, and polar climate zones.
UPPER CRETACEOUS	Extensive, powerful, megathermal, subtropical, and equatorial climates of the Paleogene and early Tertiary.
LOWER CRETACEOUS	Equatorial dry-warm season, wetter subtropical and boreal zones of the Atlantic and Indian Oceans. Subtropical and equatorial climates.
JURASSIC	Subtropical and temperate climates at the latitude of modern-day Australia.
MESO-ARCHAEOGENE F	Subtropical and temperate climates at the latitude of modern-day Australia.
PROTEROZOIC F	Subtropical and temperate climates at the latitude of modern-day Australia.
CAMBRIAN	Subtropical and temperate climates at the latitude of modern-day Australia.
PRE-CAMBRIAN	Subtropical and temperate climates at the latitude of modern-day Australia.
POLEWARD	
PLIOCENE OR PLIOGENE	Equator and mid-latitudes of Earth's surface. Short day and northern Equator fixed.
POLEWARD	
PRE-CAMBRIAN	Frozen equator and mid-latitudes of Earth's surface. Short day and northern Equator fixed.



SCALE

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NORTHERN TERRITORY

QUEENSLAND

WESTERN AUSTRALIA

MUSGRAVE RANGES

HULLAROR PLAIN

3

GREAT AUSTRALIAN BIGHT

SOUTH AUSTRALIA

SHOWING

- Artesian Basins
- Government Bores
- Groups of Mound Springs
- Isohyets
- Principal Reservoirs



- 1 Great Australian Basin
- 2 Murray River Basin
- 3 Eucla Basin
- 4 Adelaide Plains Basin
- 5 Willochra Valley Basin
- 6 Port Pirie Basin
- 7 Cowell Basin

SCALE

100 Miles
100 Kilometres
1:2,500,000
15th March 1915
Geological Survey
Government of South Australia

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